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Dear Ms Slogeris,

Re: Stage 2 Review - Flood Advice for a State Significant Concept Proposal – 39-43 Hassall Street, Parramatta, NSW, 2150 – Build-to-Rent Residential Development

Introduction

GRC Hydro (GRC) has been engaged by the NSW Department of Planning and Environment to conduct a two-stage review of flood modelling undertaken for a State Significant Development (SSD) proposed for 39-43 Hassall Street, Parramatta (the subject site). The site is situated within the City of Parramatta's (COP) Local Government Area (LGA). The Applicant proposing to develop the site is Novus, and they engaged Lyall & Associates (L&A) and Molino Stewart (MS) to conduct the flood modelling and flood-related assessment of the proposed development.

GRC's Stage 1 review submitted previously (attached as Appendix A) outlined a number of points for the Applicant's flood modellers to clarify.

This report constitutes the second stage of this review. Herein GRC will:

- Review how the concerns raised in the Stage 1 review (Appendix A) have been addressed;
- Review the site specific study and modelling conducted by Lyall & Associates and comment on whether it constitutes a suitable representation of the 2005 SKM model (COP's preferred and adopted reference for flood affectation at the site); and
- Comment on other flood-related issues raised by other stakeholders since GRC's Stage 1 Report was issued.

Reliance

The following documents have been relied upon in the course of conducting this Stage 2 review:

- Flood Enquiry Information Issued, Property Details: Address 39-41 Hassall Street, Parramatta NSW 2150, City of Parramatta, 13 December 2021;
- 39-43 Hassall Street Flooding Investigation, Lyall & Associates, December 2022;
- Architectural Report, Novus on Harris, Clay Cliff Creek, 39-43 Hassall Street, Parramatta, NSW, Rothelowman, December 2022;
- Re: 39-43 Hassall Street Parramatta – Flood Risk Assessment, Molino Stewart, 13 January 2023;
- Flood Emergency Response Plan, 39-43 Hassall Street, Parramatta, Molino Stewart, February 2023;
- Council Submission, Notice Of Exhibition – Novus Build-To-Rent Development (Ssd-34919690) At 39-43 Hassall Street, Parramatta, City of Parramatta, 29 March 2023;
- Subject: EHG comments on the Environment Impact Statement for Novus Build to Rent – proposed mixed use development – 39-43 Hassall Street, Parramatta (SSD-34919690), Environmental Heritage Group (EHG), 31 March 2023;
- Environmental Impact Assessment for Novus Build to Rent 39-43 Hassall Street Parramatta, State Emergency Services (SES), 3 April 2023;
- Re: 39-43 Hassall Street, Parramatta – Response to Submissions, Molino Stewart, 20 June 2023 (referred to herein as “Molino Stewart’s Response”);
- Subject: EHG comments on the Submissions Report for Novus Build to Rent – proposed mixed use development – 39-43 Hassall Street, Parramatta (SSD-34919690), 18 July 2023;
- Council Submission: Advice on Response to Submissions (RTS) – Novus Build-to-Rent Development (SSD-34919690) at 39-43 Hassall Street, Parramatta, 26 July 2023;
- Re: 39-43 Hassall Street, Parramatta – Response to Further Submissions, Molino Stewart, 11 August 2023;
- Re: 39-43 Hassall Street, Parramatta – Response to Further Submissions, Lyall & Associates, 14 August 2023; and
- Subject: EHG comments on Applicants most recent response of 14 September 2023 for Novus Build to Rent – proposed mixed use development – 39-43 Hassall Street, Parramatta (SSD-34919690), EHG, 13 October 2023.

Background

The subject site is located immediately adjacent to Clay Cliff Creek on its northern side. Clay Cliff Creek is a tributary of the Parramatta River. It rises south and west of the Parramatta CBD and at the subject site has a catchment of approximately 2.5 km².

Clay Cliff Creek sets the 1% AEP levels at the subject site and hence is the main focus for the Applicant’s flood modelling and reporting work.

COP have advised that the model relevant to the subject site is the one used in the 2005 SKM study and results from that assessment should be utilised in assessing the design. It is the case however that in September 2023, the Draft Parramatta River Flood Study was released. On enquiry, COP specifically advised

against use of the model or model results at this time as the study is yet to be adopted. (This was confirmed in a call with a COP representative on Thursday, 21 September, 2023 at 11.00.)

Given the 2005 model was not available for this site-specific study, L&A – on behalf of the Applicant – needed to develop a site-specific flood assessment as to demonstrate compliance, they needed to model the potential impact of the proposed development on the existing flooding affectation at and surrounding the subject site.

L&A developed a model that attempted to best represent the 2005 model. The flood modelling tools available in 2022/2023 have improved relative to those available in 2005. It is prudent to use the best practice methodology and tools available and L&A have done this by building their site-specific model in TUFLOW (a 2D hydraulic modelling software package) as opposed to MIKE-11 (a 1D hydraulic modelling software package).

In the course of reviewing the 2005 model relative to the catchment in 2022/2023, the applicant discovered that the 2005 modelling work was no longer representative of current day conditions. Furthermore, it was assessed that bridge crossings traversing Clay Cliff Creek were misrepresented as culvert-like structures in the 2005 model resulting in an overestimate of the flood levels upstream of each bridge structure.

Review of Response to GRC's Stage 1 Requests

GRC previously provided a Stage 1 report reviewing the proposed works for compliance with requirements (LEP and DCP). As part of this work GRC reviewed the site-specific flood report provided by the applicant. At the conclusion of GRC's Stage 1 Review, a number of points of clarification were raised. Table 1 below documents these points and GRC's summary of the Applicant's response.

Table 1: Stage 1 Information Request and Summary

GRC's Stage 1 Request	GRC's Summary of Response
<p>GRC requested that <i>“Lyll & Associates offer more information as to why it was prudent to update the model in TUFLOW and why they believe that the TUFLOW modelling results are more representative of local flood behaviour than the Council-provided flood levels. Verification details would be appropriate in this regard.”</i></p>	<p>L&A have provided GRC with their model and have discussed (in Molino Stewart’s 20 June 2023 response and in a video conference held on 30 May, 2023 at 10.00) how their model has attempted to represent the 2005 modelling albeit with amendments to account for:</p> <ul style="list-style-type: none"> • Improvements in modelling tools and methodology in the time since the adoption of the 2005 model (the use of two-dimensional TUFLOW to upgrade the one-dimensional MIKE-11 model); • Physical changes that have occurred in the catchment since the adoption of the 2005 model – namely the introduction of a detention basin in Ollie Webb Reserve upstream of Clay Cliff Creek; and • Improved representation of Clay Cliff Creek bridge crossings to correct being represented as culverts in the 2005 model. <p>Additionally, components of L&A’s provided model support that their site-specific model has attempted to emulate the 2005 model conditions. Most notably, the L&A model’s 1% AEP flow rate for Clay Cliff Creek and the tailwater are reflective of the values used in the 2005 model.</p> <p>The 1% AEP Clay Cliff Creek flow rate applied in the L&A model was 34 m³/s, a calculated flow rate that is similar yet more conservative than the flow rate used in the 2005 study (28 m³/s).</p> <p>In L&A’s model, a tailwater of 5.18 mAHD has been applied at Alfred Street approximately 560 m downstream of the site. This tailwater level seems conservative given it’s 0.4 m above the ground level at Alfred St (where it’s applied) and only 0.22 m below the 2005 1% AEP peak at this location.</p> <p>GRC has reviewed the Manning’s ‘n’ roughness values applied throughout the catchment in L&A’s model, and can confirm that the values applied are sensible and appropriate roughness values consistent with best practice.</p>
<p>Lyll & Associates offer some more information as to why 15% is an appropriate blockage factor for the bridges crossing Clay Cliff Creek, including the Harris Street bridge</p>	<p>L&A provided GRC with their ARR 2019 Blockage Assessment Form. On review of this form, GRC is confident that L&A’s adopted blockage factor (15%) is a conservative representation of the potential blockage at the site (Harris St bridge).</p> <p>GRC has reviewed L&A’s blockage assessment and it is GRC’s opinion that the blockage could reasonably be calculated as 0% as per the ARR2019 blockage assessment methodology.</p>

GRC's Stage 1 Request

GRC's Summary of Response

Lyall & Associates provide additional information – in addition to Section 5.4.2 of the Flooding Investigation – as to why they believe the potential climate change conditions adopted for this modelling, including the stated tailwater increase, would be representative of the potential climate change impact in this catchment;

L&A's justification for the Climate Change conditions adopted for this study is as follows (as outlined in Molino Stewart's 20 June 2023 response):

"Given that the design life of the proposed development does not extend beyond 2100, the following conditions were used:

- *A 0.9 m sea level rise by the year 2100, as recommended by the NSW Government's Sea Level Rise Policy Statement (DECCW, 2009) and used in the Hawkesbury-Nepean Valley Regional Flood Study (WMAwater,2019)*
- *A 19.7% rainfall increase by 2090, based on the ARR-recommended RCP 8.5 high emissions scenario for Sydney."*

GRC is of the opinion that these are reasonable Climate Change assumptions for this site and location.

GRC's Stage 1 Request

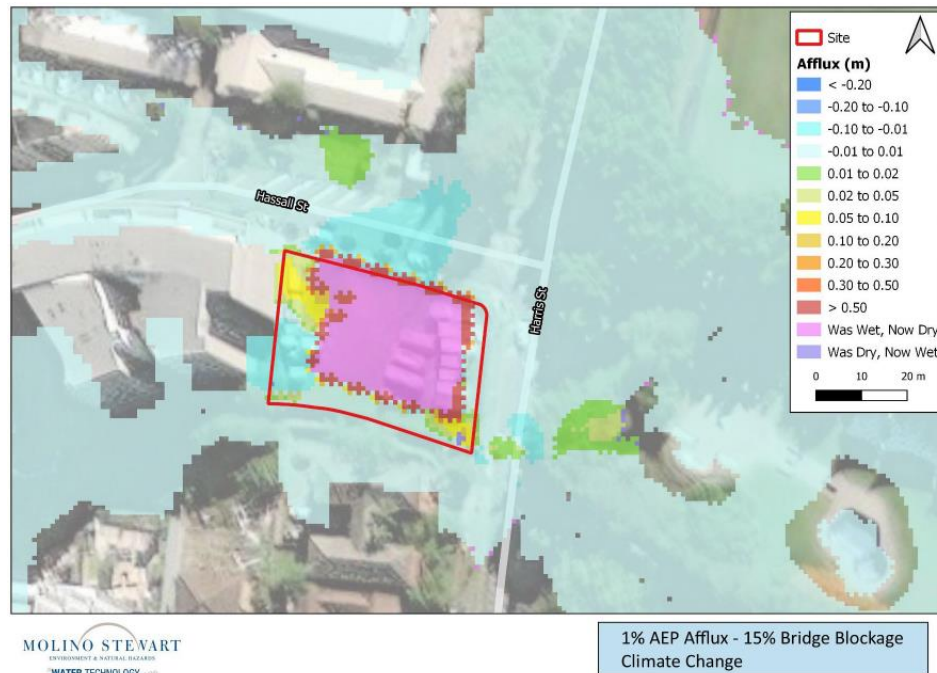
GRC's Summary of Response

Lyall & Associates provide a figure documenting the flood impact of the proposed development on flood behaviour under potential future climate change conditions in a 1% AEP event. In other words, a figure that identifies the flood level difference between:

- The 1% AEP event with potential future climate change conditions – post-development scenario; and
- The 1% AEP event with potential future climate change conditions – existing scenario.

L&A and MS provided this figure in their 20 June 2023 response (see Figure 1 below).

Figure 1: 1% AEP Flood Level Difference under 15% Bridge Blockage + Climate Change Scenario – Proposed Development minus Existing Case



Lyall & Associates provide an assessment of the impact of proposed works given assumed 50% blockage of Harris Street bridge only.

Following clarification of L&A's use of the ARR 2019 Blockage Assessment for Harris Street bridge, this was no longer deemed necessary as GRC concurred with the Applicant that a 15% blockage factor for Harris Street bridge was a conservative assumption given that the blockage factor could reasonably be calculated to be 0% as per the ARR 2019 Blockage Assessment methodology.

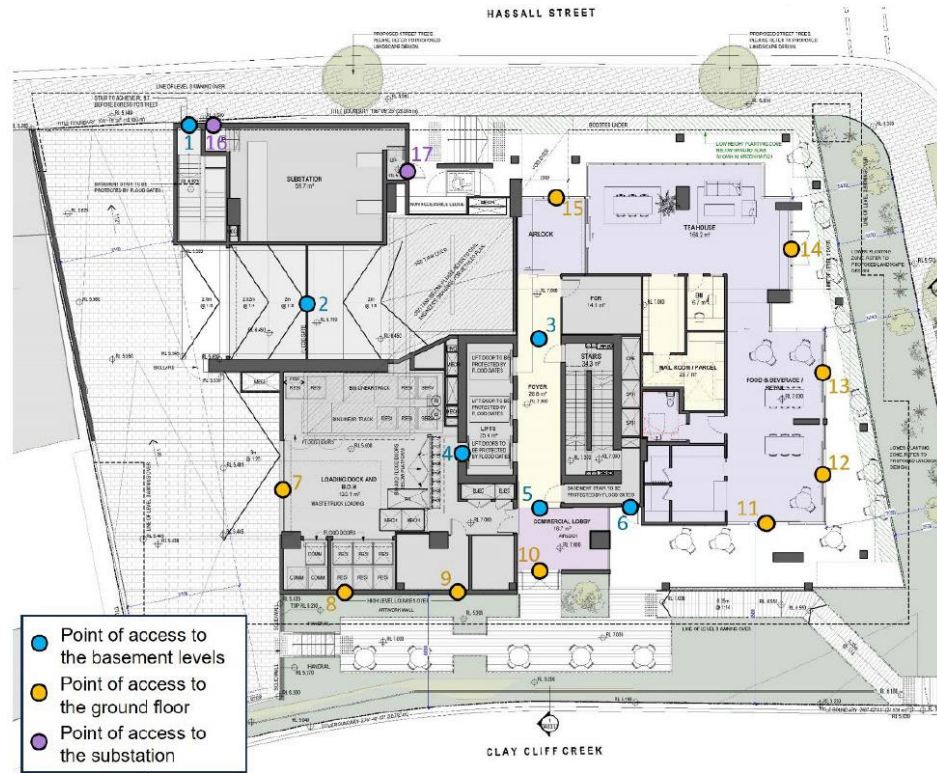
GRC's Stage 1 Request

Molino Stewart confirm that there are no additional egress points on the ground floor than those identified in Figure 15 in GRC's Stage 1 Review.

GRC's Summary of Response

MS's 20 June 2023 response noted that the ground floor layout had been amended since the completion of the Stage 1 review. MS collated a map of all of the updated ground floor egress points (Figure 2 below).

Figure 2: MS map indicating potential points of floodwater ingress (20 June 2023)



The Flood Risk Assessment mentions that protection is offered up to the PMF level. GRC request that Molino Stewart confirm the level (in mAHD) of protection offered by the flood gates and doors identified in Figure 15 and Table 1 in GRC's Stage 1 Review.

MS provided the below table identifying the newly updated ingress points, the level of protection offered at each point and GRC's assessment of whether adequate flood protection is afforded as per the DCP.

Table 1A: Ingress points and level of flood protection

Point ID	Notes	Is a Flood Barrier Required?	GRC Response
01 •	Provides external access to the basement levels. The stairs climb to 6.823 m AHD, providing passive flood protection up to above the FPL (6.6 m AHD in this location). A flood barrier will provide active flood protection up to the PMF.	Yes, up to PMF (9.5 m AHD)	Flood protection requirement for basement (via stairwell) satisfied.
02 •	Provides external access to the basement levels. The ramp crest is at 6.7 m AHD, providing passive flood protection up to above the FPL (6.6 m AHD in this location). A flood barrier will provide active flood protection up to the PMF level.	Yes, up to PMF (9.5 m AHD)	Flood protection requirement for basement (via driveway) satisfied.
03 •	Provides access to the basement levels. The ground floor level is 7.0 AHD, providing passive protection up to above the FPL (6.6 m AHD in this location). A flood barrier will provide active flood protection up to the PMF level.	Yes, up to PMF (9.5 m AHD)	Flood protection requirement for basement (via lifts and stairwell) satisfied.
04 •	Provides access to the basement levels. The elevation of the loading dock platform is 7.0 AHD, providing passive protection up to above the FPL (6.6 m AHD in this location). A flood barrier will provide active flood protection up to the PMF level.	Yes, up to PMF (9.5 m AHD)	Flood protection requirement for basement (via lifts and stairwell) satisfied.
05 •	Provides access to the basement levels. The ground floor level is 7.0 AHD, providing passive protection up to above the FPL (6.6 m AHD in this location). A flood barrier will provide active flood protection up to the PMF level.	Yes, up to PMF (9.5 m AHD)	Flood protection requirement for basement (via lifts and stairwell) satisfied.
06 •	Provides access to the basement levels. The ground floor level is 7.0 AHD, providing passive protection up to above the FPL (6.6 m AHD in this location). A flood barrier will provide active flood protection up to the PMF level.	Yes, up to PMF (9.5 m AHD)	Flood protection requirement for basement (via lifts and stairwell) satisfied.
07 •	Provides external access to the loading dock, does not provide access to the basement. The loading dock itself does not need to be protected from flooding, but waste storage	Yes, up to the FPL (6.6 m)	Flood protection requirement for waste storage satisfied.

	within the loading dock needs to be protected up to the FPL.	AHD in this location)	
08 •	Louvres located above the PMF level (9.5 m AHD). As they are located above potential floodwaters, the louvres do not represent potential points of floodwater ingress to the loading dock, ground floor or basement levels.	No	Satisfied that this opening is confirmed elevated above the PMF level hence no flood protection is required.
09 •	Louvres located above the PMF level (9.5 m AHD). As they are located above potential floodwaters, the louvres do not represent potential points of floodwater ingress to the loading dock, ground floor or basement levels.	No	Satisfied that this opening is confirmed elevated above the PMF level hence no flood protection is required.
10 •	Provides access to the ground floor. The ground floor level is 7.0 m AHD, providing passive flood protection up to above the FPL (6.8 m AHD in this location).	No	Satisfied that this access point provides adequate passive flood protection. Ingress to the basement is protected further inside the building.
11 •	Provides access to the ground floor. The ground floor level is 7.0 m AHD, providing passive flood protection up to above the FPL (6.8 m AHD in this location).	No	Satisfied that this access point provides adequate passive flood protection. Ingress to the basement is protected further inside the building.
12 •	Provides access to the ground floor. The ground floor level is 7.0 m AHD, providing passive flood protection up to above the FPL (6.6 m AHD in this location).	No	Satisfied that this access point provides adequate passive flood protection. Ingress to the basement is protected further inside the building.
13 •	Provides access to the ground floor. The ground floor level is 7.0 m AHD, providing passive flood protection up to above the FPL (6.6 m AHD in this location).	No	Satisfied that this access point provides adequate passive flood protection. Ingress to the basement is protected further inside the building.

14 •	Provides access to the ground floor. The ground floor level is 7.0 m AHD, providing passive flood protection up to above the FPL (6.6 m AHD in this location).	No	Satisfied that this access point provides adequate passive flood protection. Ingress to the basement is protected further inside the building.
15 •	Provides access to the ground floor. The ground floor level is 7.0 m AHD, providing passive flood protection up to above the FPL (6.6 m AHD in this location).	No	Satisfied that this access point provides adequate passive flood protection. Ingress to the basement is protected further inside the building.
16 •	Provides access to the substation. The substation floor level is 6.2 m AHD, 0.1 m above the 1% AEP flood level in this location (with 15% bridge blockage)	No	Satisfied that this access point provides adequate passive flood protection. Ingress to the basement is protected further inside the building.
17 •	Provides access to the substation. The substation floor level is 6.2 m AHD, 0.1 m above the 1% AEP flood level in this location (with 15% bridge blockage)	No	Satisfied that this access point provides adequate passive flood protection. Ingress to the basement is protected further inside the building.

Additionally, in Molino Stewart’s 11 August 2023 response, MS identified how the proposed design satisfied the development control conditions when compared with the 2005 SKM flood levels. These are identified in Table 1B below.

Table 1B: Ingress points and level of flood protection

Location	Council’s adopted 1% AEP Flood Level (m AHD)	FPL based on Council’s adopted flood level (m AHD)	FPL adopted based on Lyall and Associates modelling (m AHD)	Level adopted for architectural purposes (m AHD)
Hassall Street frontage	6.2	6.7	6.6	7.0 (ground floor level)
Driveway in front of basement ramp	6.2	6.7	6.6	6.7 (basement ramp crest)
South-western corner of site	6.2	6.7	6.8	7.0 (ground floor level)
South-eastern corner of site	6.2	6.7	6.7	7.0 (ground floor level)

In summary, GRC is satisfied that L&A and MS have adequately answered the questions GRC put to them regarding the basis for their modelling.

Review of Response to EHG's, COP's and SES's Requests

In addition to the questions raised by GRC's Stage 1 Review, during the subsequent period, further feedback was received from other stakeholders on the Applicant's design, modelling and reporting.

These were documented in the following submissions to DPE:

- Council Submission, Notice Of Exhibition – Novus Build-To-Rent Development (Ssd-34919690) At 39-43 Hassall Street, Parramatta, City of Parramatta, 29 March 2023;
- Subject: EHG comments on the Environment Impact Statement for Novus Build to Rent – proposed mixed use development – 39-43 Hassall Street, Parramatta (SSD-34919690), Environmental Heritage Group (EHG), 31 March 2023;
- Environmental Impact Assessment for Novus Build to Rent 39-43 Hassall Street Parramatta, State Emergency Services (SES), 3 April 2023;

Molino Stewart responded to all of the issues raised in the SES, COP and EHG letters in their 20 June 2023 response.

GRC reviewed these responses and sought further clarity from Molino Stewart as to why, specifically, Molino Stewart and Lyall & Associates believed the 2005 SKM to be inadequate to determine flood affectation in this local area. The Applicant provided:

- the model to GRC;
- an additional letter (Re: 39-43 Hassall Street, Parramatta – Response to Further Submissions, Lyall & Associates, 14 August 2023.); and
- a complete ARR2019 Blockage Assessment.

As outlined in Table 1 above, GRC is satisfied with the rationale for the modelling approach and the results of this modelling.

A number of the agencies submitted further comments in response to MS's 20 June 2023 response. These are as follows:

- Review and Comments: NCA/3/2022 (39-43 Hassall St Parramatta), City of Parramatta, 12th July, 2023;
- Subject: EHG comments on the Submissions Report for Novus Build to Rent – proposed mixed use development – 39-43 Hassall Street, Parramatta (SSD-34919690), EHG, 18 July 2023;
- Council Submission: Advice on Response to Submissions (RTS) – Novus Build-to-Rent Development (SSD-34919690) at 39-43 Hassall Street, Parramatta, City of Parramatta, 26 July 2023.

The Applicant responded to the concerns raised in the above documents in the following report:

- Re: 39-43 Hassall Street, Parramatta – Response to Further Submissions, Lyall & Associates, 14 August 2023;

EHG then submitted an additional response on 13 October 2023:

- Subject: EHG comments on Applicants most recent response of 14 September 2023 for Novus Build to Rent – proposed mixed use development – 39-43 Hassall Street, Parramatta (SSD-34919690), EHG, 13 October 2023.

This letter indicated that EHG have continuing concerns about the following:

- The use of flood gates to protect the basement car park;
- The use of flood gates for impact mitigation;
- The time of isolation;
- Compliance with LEP Clause 7.9 (now Clause 7.11 3(b) in the updated 2023 LEP); and
- Flood function and flood impact (i.e. disagreement that the Applicant’s site-specific flood modelling is appropriate)

It is GRC’s understanding that the use of flood gates for the protection of basements in a flood event is allowed and supported by Council given their inclusion in the DCP as a legitimate flood protection tool for prospective developments (as referenced in the below extract from the newly adopted Parramatta DCP (2023) (Section 5.1.1, C.22 (c))):

- c) **The basement must be protected from the ingress of floodwater via the driveway up to the Probable Maximum Flood level. These measures are likely to include provision of a self-triggering and self-powered flood gate at or near the driveway crest that reaches the level of the PMF, together with corresponding wing wall bunds etc. to the same PMF level.**

Flood impacts have been modelled, with the inclusion of the small flood gate proposed for the interface between the driveway and the northern bank of Clay Cliff Creek. GRC review finds that the scale of flood impact is compliant with Council’s planning instruments.

Sheltering in place is a strategy supported by Council’s DCP in order to account for the complexity of facilitating development in the Parramatta CBD and doing so in a way that is safe and considerate of flood risk. The Applicant has stated that there is a provision for back-up power in the event of a flood emergency.

GRC review finds that the development satisfies subclause 3 (b), which requires that the site “has an emergency access point to land above the 1% annual exceedance probability event” through the provision of an access/egress point has been proposed in the form of the jetty and walkway connecting the development and a parcel of Harris St that lies above the 1% AEP flood level (given the adoption of a 0% AEP blockage factor, which GRC believes is appropriate on review of the ARR 2019 Blockage Assessment for the site as provided by the Applicant).

As demonstrated previously, GRC is of the view that the Applicant’s provided flood modelling provides a best-practice representation of flood affectation in this catchment.

Compliance with the Relevant Planning Instruments

GRC note that through the course of the application and review process, both the Parramatta LEP and DCP have been updated and new versions have been adopted.

GRC have reviewed these updated planning instruments relative to their prior versions and have found few material differences with regard to flooding.

In aid of evaluating the residual compliance of the proposed development after assessing all of the submissions made, GRC has returned to the adopted Parramatta LEP and DCP (2023) to determine whether the proposed development still complies with the relevant planning instruments after considering the input offered from the various stakeholders to date.

Compliance is explored and documented in Tables 2 to 5 below.

Parramatta Local Environmental Plan (2023)

Table 2: Compliance of the Proposed Development with Parramatta LEP 2023

Planning Control	GRC's Summary of Response
Parramatta Local Environmental Plan (2023) – Clause 5.21 – Flood Planning	
(1) The objectives of this clause are as follows— (a) to minimise the flood risk to life and property associated with the use of land,	<p>The proposed development has been designed cognisant of the site's flood affectation. Proposed floor levels, internal refuge areas and flood protection measures – both passive and active – have been proposed in compliance with the controls identified in the Parramatta Development Control Plan (2023) in order to adequately minimise the flood risk to life and property for the proposed land use.</p> <p>GRC review finds that the proposed development complies in this regard.</p>

Planning Control**GRC's Summary of Response**

Parramatta Local Environmental Plan (2023) – Clause 5.21 – Flood Planning

(b) to allow development on land that is compatible with the flood function and behaviour on the land, taking into account projected changes as a result of climate change,

From Molino Stewart's Flood Risk Assessment (13 January 2023):

“The Flood Enquiry Information provided by Council indicates that the entire site is high hazard in the 1% AEP flood, which places the site in the High Flood Risk Precinct. However, modelling of overland and creek flooding by Lyall and Associates shows that in the 1% AEP event most of the proposed development is surrounded by H1 and H2 (low hazard) floodwaters, with H3 (medium hazard) flooding along the southern setback and at the southern end of the driveway (Figure 4). The site should therefore more appropriately be considered to be in the Medium Flood Risk Precinct.

The proposed development demonstrates that it is compatible with the nature of flooding on the land through compliance with the specific requirements from the Paramatta DCP 2011, as outlined in Sections 4.1 and 4.2 of this report.”

GRC, accepting the validity of Lyall & Associates modelling approach and results, accepts the above assertion that the proposed development is compatible with the flood function and behaviour of the land.

GRC review finds that the proposed development **complies** in this regard.

Parramatta Local Environmental Plan (2023) – Clause 5.21 – Flood Planning

(c) to avoid adverse or cumulative impacts on flood behaviour and the environment,

Lyall & Associates have modelled the flood level impact of the proposed development and this modelling indicated the development would not adversely impact flood behaviour in the design event, with no significant increase of flood levels on surrounding properties.

For the most part, no change or a reduction in level is predicted. Minor off-site increases (less than 0.05m) are predicted in a small parcel where Clay Cliff Creek meets Harris St (see Figure 3).

Figure 3: Flood Level Difference (Proposed minus Existing case) – 1% AEP Design Event including 15% Bridge Blockage



A comparison of velocity mapping shows some localised changes in velocity in the immediate vicinity of the site, that would not impact any sites or the flood risk.

There is no indication of a significant loss of flood storage. Impact assessment of cumulative development in the area has not been carried out but, so long as similar development also shows no impact on flood behaviour, this would likely not be significant.

GRC review finds that the proposed development **complies** in this regard.

Planning Control
GRC's Summary of Response

Parramatta Local Environmental Plan (2023) – Clause 5.21 – Flood Planning

(d) to enable the safe occupation and efficient evacuation of people in the event of a flood.

The Applicant's proposal includes ample safe refuge area on the second floor for occupants to shelter in place in the event of an emergency.

Shelter in place is mentioned as an appropriate strategy in the DCP for a development of this type.

Flood alarms, passive and active flood protection measures and back-up provision of electricity and water supply have been proposed to facilitate the safe alerting, movement and sheltering of occupants in the event of a flood emergency.

GRC review finds that the proposed development **complies** in this regard.

(2) Development consent must not be granted to development on land the consent authority considers to be within the flood planning area unless the consent authority is satisfied the development—
(a) is compatible with the flood function and behaviour on the land, and

From Molino Stewart's Flood Risk Assessment (13 January 2023):

"The Flood Enquiry Information provided by Council indicates that the entire site is high hazard in the 1% AEP flood, which places the site in the High Flood Risk Precinct. However, modelling of overland and creek flooding by Lyall and Associates shows that in the 1% AEP event most of the proposed development is surrounded by H1 and H2 (low hazard) floodwaters, with H3 (medium hazard) flooding along the southern setback and at the southern end of the driveway (Figure 4). The site should therefore more appropriately be considered to be in the Medium Flood Risk Precinct.

The proposed development demonstrates that it is compatible with the nature of flooding on the land through compliance with the specific requirements from the Paramatta DCP 2011, as outlined in Sections 4.1 and 4.2 of this report."

GRC, accepting the validity of Lyall & Associates modelling approach and results, accepts the above assertion that the proposed development is compatible with the flood function and behaviour of the land.

GRC review finds that the proposed development **complies** in this regard.

Planning Control

GRC's Summary of Response

Parramatta Local Environmental Plan (2023) – Clause 5.21 – Flood Planning

<p>(b) will not adversely affect flood behaviour in a way that results in detrimental increases in the potential flood affectation of other development or properties, and</p>	<p>As per the answer to 1(c), the impact of the proposed development has been modelled and there is no adverse impact to other properties as a result of this development.</p> <p>GRC review finds that the proposed development complies in this regard.</p>
<p>(c) will not adversely affect the safe occupation and efficient evacuation of people or exceed the capacity of existing evacuation routes for the surrounding area in the event of a flood, and</p>	<p>The Applicant has proposed a detailed shelter in place strategy for this development. Provision has been made to support the sheltering of all occupants on the upper floors of the proposed development for up to 6 hours (the duration of predicted inundation in a PMF event) with back up power and water access.</p> <p>As such, no additional burden is predicted to be placed on the capacity of existing evacuation routes in the surrounding area in the event of a flood.</p> <p>GRC review finds that the proposed development complies in this regard.</p>

Planning Control
GRC's Summary of Response

Parramatta Local Environmental Plan (2023) – Clause 5.21 – Flood Planning

(d) incorporates appropriate measures to manage risk to life in the event of a flood, and

The basement levels are proposed to be protected from floodwaters up to the FPL by passive flood protection measures.

The basement levels are proposed to be protected from flood levels from the FPL up to and including the riverine PMF by active measures, such as flood gates and flood doors.

Evacuation of the basement and ground floors will be triggered when riverine flood levels reach those of a 5% AEP event, when a Major Flood Warning is issued or when the landscaped area adjacent to the creek starts to flood. This will provide sufficient time for these areas to evacuate before floodwaters exceed the FPL, although the basement will be protected from flooding of all magnitudes.

Additionally, the Applicant has stated that the proposed development will have:

- ample refuge areas above the PMF level;
- passive and active flood protection to facilitate safe access to refuge areas above the PMF level;
- back-up electricity and water supply to support shelter in place for 6 hours.

A detailed Flood Emergency Response Plan has been developed for the proposed development.

GRC review finds that the proposed development **complies** in this regard.

(e) will not adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.

Clay Cliff Creek flows through a concrete lined canal south of the site. The proposed development will not destroy riparian vegetation or reduce the stability of the creek banks.

GRC review finds that the proposed development **complies** in this regard.

Planning Control
GRC's Summary of Response

Parramatta Local Environmental Plan (2023) – Clause 5.21 – Flood Planning

<p>(3) In deciding whether to grant development consent on land to which this clause applies, the consent authority must consider the following matters—</p> <p>(a) the impact of the development on projected changes to flood behaviour as a result of climate change,</p>	<p>Modelling by Lyall and Associates shows that in post-development conditions with ideal flow climate change has the potential to increase 1% AEP flood levels at the site by as much as 0.6 m by the year 2100.</p> <p>In the south-western corner of the site the flood level would increase to 6.4 m AHD, which is 0.6 m below the ground floor level of the proposed development. In the vicinity of the basement ramp climate change would increase the 1% AEP flood level to 6.3 m AHD, which remains 0.4 m below the ramp crest.</p> <p>GRC, accepting the validity of Lyall & Associates modelling approach, finds the proposed development complies in this regard.</p>
<p>(b) the intended design and scale of buildings resulting from the development,</p>	<p>From Molino Stewart's Flood Risk Assessment (13 January 2023):</p> <p><i>"The development will consist of a 34-storey build-to-rent residential tower and mixed-use podium. The ground floor will have a tea house and mail room intended to be in operation at all times, as well as a food and beverage/retail area that will be in operation two thirds of the time.</i></p> <p><i>Level 1 will contain commercial premises, which are only expected to be occupied two thirds of the time.</i></p> <p><i>All apartments are above the PMF level on levels 3 and above and there are residential facilities on levels 2 and 32.</i></p> <p><i>The basement levels are all designed to include short-stay uses, including car parking, storage, bike storage, plant and E.O.T. bathroom facilities.</i></p> <p><i>The basement levels are protected from flooding up to the riverine PMF level."</i></p> <p>GRC review finds that the proposed development complies in this regard.</p>

Planning Control	GRC's Summary of Response
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Parramatta Local Environmental Plan (2023) – Clause 5.21 – Flood Planning

<p>(c) whether the development incorporates measures to minimise the risk to life and ensure the safe evacuation of people in the event of a flood,</p>	<p>From Molino Stewart's Flood Risk Assessment (13 January 2023):</p> <p><i>"The basement levels are protected from floodwaters up to the FPL by passive flood protection measures.</i></p> <p><i>The basement levels are protected from flood levels from the FPL up to and including the riverine PMF by active measures, such as flood gates and flood doors.</i></p> <p><i>Early evacuation of the ground and basement levels will minimise the risk to life posed by a creek or riverine PMF.</i></p> <p><i>The development is to have a Flood Emergency Response Plan prepared for the site to ensure flood risk is managed appropriately."</i></p> <p>GRC review finds that the proposed development complies in this regard.</p>
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<p>(d) the potential to modify, relocate or remove buildings resulting from development if the surrounding area is impacted by flooding or coastal erosion.</p>	<p>From Molino Stewart's Flood Risk Assessment (13 January 2023):</p> <p><i>"It will not be possible to modify, relocate or remove this building as a response measure. The site is not subject to coastal erosion and the building has been designed to exclude floodwaters from the basement up to and including the riverine PMF."</i></p> <p>GRC review finds that the proposed development complies in this regard.</p>
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Planning Control	GRC's Summary of Response
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Parramatta Local Environmental Plan (2023) – Clause 7.11 – Floodplain Risk Management

<p>(1) The objective of this clause is to enable occupants of buildings in certain areas subject to floodplain risks—</p> <p>(a) to shelter in a building above the probable maximum flood level, or</p> <p>(b) to evacuate safely to land above the probable maximum flood level.</p>	<p>Provision has been made to allow for the safe shelter of occupants inside the building above the probable maximum flood level. This is further explained in response to Clause (3) below.</p> <p>In satisfying 1 (a), GRC review finds that the proposed development complies in this regard.</p>
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Planning Control**GRC's Summary of Response**

Parramatta Local Environmental Plan (2023) – Clause 7.11 – Floodplain Risk Management

(2) This clause applies to land identified as “Floodplain Risk Management Area” on the Floodplain Risk Management Map.

This land is identified as such.

(3) Development consent must not be granted to the erection of a building on the land unless the consent authority is satisfied the building—

The proposed development includes ample area that is safe for the refuge of occupants above the PMF level.

This includes:

(a) contains an area that is—
(i) located above the probable maximum flood level, and

- a “gym and flexi space on Level 2” which will function as a communal refuge area; and
- residential units on the floors above.

GRC review finds that the proposed development **complies** in this regard.

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Parramatta Local Environmental Plan (2023) – Clause 7.11 – Floodplain Risk Management

(ii) connected to an emergency electricity and water supply, and

The Applicant has stated that an emergency supply of electricity and water will be provided to support shelter in place for a duration of 6 hours.

As per Molino Stewart's 11 August 2023 letter: *"The 6-hour duration is an estimate of how long the PMF will flood the site based on an analysis undertaken by Molino Stewart in 2015 to inform updates to the Parramatta Local Environment Plan (LEP) and Development Control Plan (DCP) for the Parramatta CBD.*

The analysis was based on hydrographs provided by Council from the Upper Parramatta Catchment Trust Mike 11 model, which is used by Council for most of the CBD rather than the SKM Lower Parramatta River Mike 11 model (these are Council's adopted models for riverine flooding)."

According to Molino Stewart's Flood Risk Assessment (13 January 2023):

"Residents sheltering in their rooms will have access to emergency electricity, back-up water and wastewater services, kitchens, their own belongings and bathroom facilities. The gym and flexi space on Level 2 is the communal refuge area. Occupants of this floor would have access to emergency electricity, back-up water and wastewater services, bathrooms facilities and first aid kits. The FERP includes actions for maintaining the measures required to implement vertical evacuation in perpetuity.

The refuge facilities have been designed for a refuge stay of 6 hours. The development has a 24-hour back-up power supply in addition to 6-hour back-up supply of water and wastewater services... 6 hours of back-up services is sufficient to shelter site occupants during a flood.

The building design and back-up systems enable residents to safely remain in their rooms during a flood. All building occupants will have access to the communal refuge area where emergency supplies will be available. The communal refuge will have emergency electricity and lighting, clean water, working bathroom facilities, suitable food, washing facilities, medical equipment, first aid kits and a battery-powered radio."

GRC review finds that the proposed development **complies** in this regard.

Planning Control
GRC's Summary of Response

Parramatta Local Environmental Plan (2023) – Clause 7.11 – Floodplain Risk Management

<p>(iii) of sufficient size to provide refuge for all occupants of the building, including residents, workers and visitors, and</p>	<p>The development will provide unrestricted access via stairs from the basement to Levels 1 and above, which is 1.1 m above the riverine PMF flood level.</p> <p>All of the building's floors above – and not including – the ground floor can therefore function as a PMF refuge. The designated communal flood refuge is on Level 2, which is accessible via the stairs and is 4.9 m above the riverine PMF level.</p> <p>GRC review finds that the proposed development complies in this regard.</p>
<p>(b) has an emergency access point to land above the 1% annual exceedance probability event, and</p>	<p>Lyall & Associates modelled the 1% AEP design flood under two bridge blockage scenarios: a 15% blockage scenario and a 0% blockage scenario.</p> <p>GRC's review of Lyall & Associates ARR 2019 Blockage Assessment of Clay Cliff Creek identified that the 15% blockage figure was a conservative assumption and that the blockage value could reasonably be calculated as 0% given the nature of the channel and the adjacent, upstream properties. Under this scenario, the proposed development would have an emergency access point and is considered compliant.</p>
<p>(c) is able to withstand the forces of floodwaters, debris and buoyancy resulting from a probable maximum flood event.</p>	<p>An engineer's report will be obtained to certify that the structure can withstand the forces of floodwater, debris and buoyancy up to and including the level of the FPL (9.5 m AHD).</p> <p>GRC review finds that the proposed development complies in this regard.</p>

Parramatta Development Control Plan (2023) – Section 5.1.1.– Flooding

Table 3: Floodplain Matrix Planning and Development Controls as per the DCP (2023):

Table 5.1.1.2 – Floodplain Matrix Planning and Development Controls

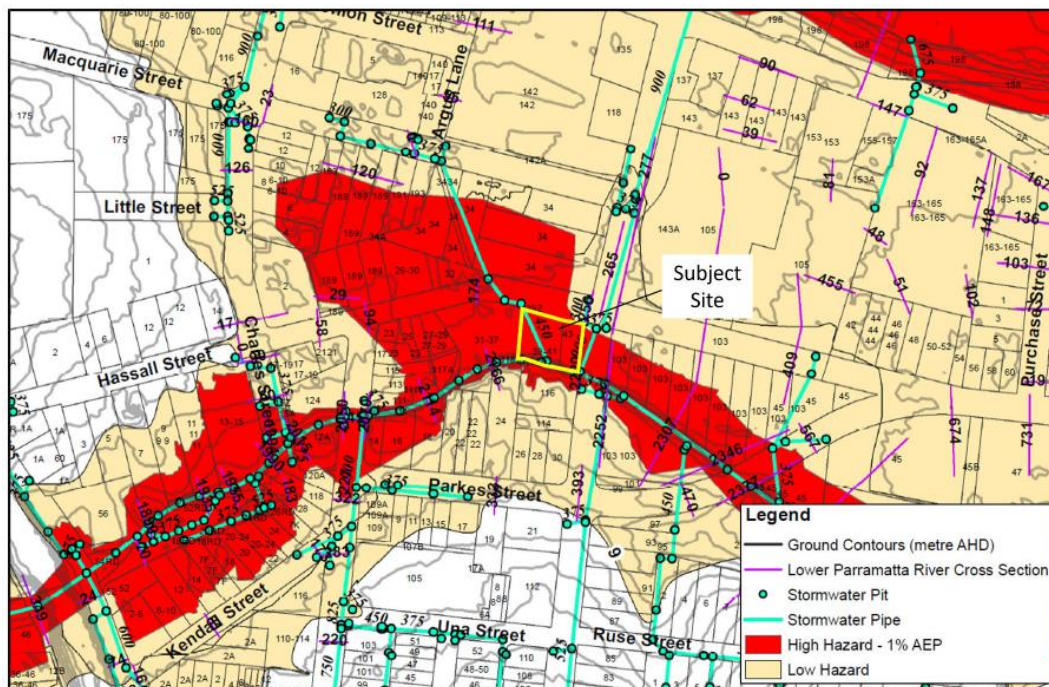
Flood Risk Precincts (FRPs)	Planning Consideration	Floor Level	Building Components	Structural Soundness	Flood Affection	Car Parking & Driveway Access	Evacuation	Management & Design
High Flood Risk	Sensitive Uses & Facilities	X	X	X	X	X	X	X
	Critical Uses & Facilities	X	X	X	X	X	X	X
	Residential*	X	X	X	X	X	X	X
	Commercial & Industrial	X	X	X	X	X	X	X
	Open Space & Non-Urban	1	1	1	1	2, 4, 6, 7	1, 4	2, 3, 4
	Subdivision	X	X	X	X	X	X	X
	Filling	X	X	X	X	X	X	X
	Concessional Development	4	1	1	1	1, 5	3, 4, 6	2, 3, 4
Medium Flood Risk	Sensitive Uses & Facilities	X	X	X	X	X	X	X
	Critical Uses & Facilities	X	X	X	X	X	X	X
	Residential*	2	1	1	1	1, 3, 5, 6, 7	3, 4, 6	2, 3, 4
	Commercial & Industrial	2	1	1	1	1, 3, 5, 6, 7	3, 4, 6	2, 3, 4
	Open Space & Non-Urban	1	1	1	2	2, 4, 6, 7	1, 4	2, 3, 4
	Subdivision				1		3, 4, 5	1
	Filling	X	X	X	X	X	X	X
	Concessional Development	4	1	1	1	1, 5	2, 5	2, 3, 4
Low Flood Risk	Sensitive Uses & Facilities	X	X	X	X	X	X	X
	Critical Uses & Facilities	3	2	2	2	1, 3, 5, 6	2, 4, 6	2, 3, 4
	Residential*	2			2	1, 3, 5, 6	3, 4	
	Commercial & Industrial	2			2	1, 3, 5, 6	4	
	Open Space & Non-Urban					2, 4, 6, 7		
	Subdivision				2		5	1
	Filling				1			
	Concessional Development							

*For redevelopment of existing dwellings refer also to 'Concessional Development' provisions.

Legend	Not relevant	X	Unsuitable Land Use
i.	Freeboard equals an additional height of 500mm.		
ii.	The flood level is usually the higher of that level adopted by Council for fluvial flooding (from rising rivers, creeks, tributaries) for a 1% Annual Exceedance Probability event (1% AEP), or the modelled overland flow flood level (from rainfall in the local catchment) for an event with the same probability (1% AEP). The Flood Planning Level is usually the 1% AEP Flood Level plus a 500mm freeboard safety factor.		
iii.	The Parramatta LEP 2023 identifies development permissible with consent in various zones. Notwithstanding, constraints specific to individual sites may preclude Council granting consent for certain forms of development on all or part of a site. The above matrix identifies where flood risks are likely to determine where certain development types will be considered "unsuitable" due to flood related risks.		
iv.	Filling of the site, where acceptable to Council, may change the FRP considered to determine the controls applied in the circumstances of individual applications.		
v.	Any fencing that forms part of a proposed development is subject to the relevant Flood Effects and Structural Soundness planning considerations of the applicable land use category.		
vi.	Development within the floodplain may be subject to Clause 6.7 Foreshore Building Line in the Parramatta LEP 2023.		
vii.	Additional controls apply to basement carparking within the floodplain, please see Car Park Basements associated controls above.		
viii.	Where a flood warning and emergency response plan is required, requirements set out below under 'Flood Warning and Emergency Response Planning' must be achieved.		

The flood information issued by the City of Parramatta identifies the site as being high hazard (Figure 4).

Figure 4: Flood Hazard (City of Parramatta issued Flooding Information for the site)



The Applicant asserts in their initial Flood Risk Assessment (13 January 2023) that in their “TUFLOW model (2022), the 1% AEP inundates parts of the site with flood waters with hydraulic hazard up to H3 (medium hazard) (Figure 4). The maximum hydraulic hazard on site would also be H3 if the creek floodwaters were to surcharge the channel in the 1% AEP event. Therefore, the site would be in the Medium Flood Risk Precinct using the precinct definitions in (Table 4 below).”

Table 4: Descriptions of flood risk precincts (from Council website)

Risk area	Common description	Technical description
High risk area	<ul style="list-style-type: none"> Frequent flooding is common Near the main river and creeks where water flows during a flood, including overflow from drainage This area will see the fastest flowing and deepest water and cause a significant risk to life 	High hazard flood area within the 1% annual exceedance probability (AEP) (1:100)
Medium risk area	<ul style="list-style-type: none"> Frequent flooding will be rare Where the flood water goes once the creek/river areas overflow In rare floods these areas have the potential for deep and fast flowing water 	Medium and low hazard area in the 1% AEP (1:100)
Low risk area	<ul style="list-style-type: none"> Flooding is extremely rare Generally, away from the river or creek and higher up If a flood affects these areas it will cover a large area with dangerous water in many places 	Area from the 1% AEP (1:100) up to the Probable Maximum Flood
Everywhere else	Not expected to flood but there still could be local incidents water running off the land and of street drainage not coping with rainfall amounts.	Area outside the Probable Maximum Flood. There may still be isolated impacts from local overland flow.

GRC, accepting the validity of the Applicant’s model, agrees that the site could reasonably be classes as Medium Flood Risk as per the Applicant's assertion.

The development is proposed to be mixed-use; Commercial at the lower levels and Residential on the floor above. As per the DCP’s Floodplain Matrix, for a site with Medium Flood Risk, Commercial & Industrial and Residential land uses share the same development control requirements. These are outlined below in Table 5 with GRC’s comments regarding the proposed development’s compliance.

Table 5: Compliance of the Proposed Development with Parramatta DCP 2023

Reference	Control	GRC Comment
PDCP 2023 Control (From Table 5.1.1.3)		
Floor Level		
2	All habitable floor levels to be equal to or greater than the 1% AEP (100 year ARI) flood level plus 0.5 metre freeboard.	All habitable floor levels have been proposed above the 1% AEP flood level inclusive of an additional 0.5 m freeboard. All habitable finished floor levels and potential points of flood ingress have been documented relative to the flood planning level in Table 1A above.

Reference	Control	GRC Comment
Building Components and Method		
1	All structures to have flood compatible building components and construction below the 1% AEP (100 year ARI) flood level plus freeboard.	<p>As per the Applicant's Flood Risk Assessment (13 January 2023):</p> <p><i>"According to Building Components and Method Control 1, all building components below the FPL will need to be of flood compatible materials. All building components below 6.6 m AHD for most of the building, below 6.8 m AHD in the south-west and below 6.7 m AHD in the south-east will be constructed of flood compatible materials."</i></p> <p>GRC review finds that the proposed development complies in this regard.</p>
Structural Soundness		
1	Unless otherwise approved by Council, a structural engineer's report is required to certify that the structure can withstand the forces of floodwater, debris and buoyancy up to and including a 1% AEP (100 year ARI) flood level plus freeboard.	<p>As per the Applicant's Flood Risk Assessment (13 January 2023):</p> <p><i>"Control 1 states that an engineer's report will be required to certify that the structure can withstand the forces of floodwater, debris and buoyancy up to and including the level of the FPL (9.5 m AHD). An engineer's report will be obtained for the proposed development."</i></p> <p>GRC review finds that the proposed development complies in this regard.</p>
Flood Affection		
1	A hydraulic engineer's report is required to certify that the development will not increase flood affection elsewhere, having regard to: (i) loss of flood storage; (ii) changes in flood levels, flows and velocities caused by alterations to flood flows; and (iii) the cumulative impact of multiple potential developments in the vicinity.	<p>Flood level impacts have been modelled by the Applicant. For the most part, no change or a reduction in level is predicted. Minor off-site increases (less than 0.05m) are predicted in a small parcel where Clay Cliff Creek meets Harris St in off-site flood level are predicted.</p> <p>A comparison of velocity mapping shows some localised changes in velocity in the immediate vicinity of the site, that would not impact any sites or the flood risk.</p> <p>There is no indication of a significant loss of flood storage. Impact assessment of cumulative development in the area has not been carried out but, so long as similar development also shows no impact on flood behaviour, this would likely not be significant.</p> <p>GRC review finds that the proposed development complies in this regard.</p>
Car Parking and Driveway Access		
1	The minimum surface level of unenclosed parking spaces or carports shall be as high as practical, but no lower than 0.1 metres	<p>Basement car parking is proposed for this development. This basement will be protected through the inclusion of a crest with a finished surface level of 6.7 mAHD, providing</p>

Reference	Control	GRC Comment
	<p>below the 1% AEP (100 year ARI) flood level. In the case of garages and other enclosed parking areas for less than 3 motor vehicles, the minimum surface level shall be as high as practical, but no lower than the 1% AEP (100 year ARI) flood level, plus 0.15 metres freeboard.</p>	<p>passive flood protection up to above the FPL (6.6 mAHD in this location using the Applicant’s modelling, or 6.7 mAHD using Council’s adopted SKM 2005 levels). A flood barrier will provide active flood protection up to the PMF level.</p> <p>GRC review finds that the proposed development complies in this regard.</p>
3	<p>Garages, and other enclosed car parking areas, capable of accommodating more than 3 motor vehicles, must be protected from inundation by floods equal to or greater than the 1% AEP (100 year ARI) flood. Ramp levels to be no lower than 0.5m above the 100 year ARI flood level. Where below ground car parking is proposed additional measures must achieve protection up to the PMF.</p>	<p>The proposed driveway that leads to the basement car park will have a crest with a finished surface level of 6.7 mAHD, providing passive flood protection up to above the FPL (6.6 mAHD in this location using the Applicant’s modelling, or 6.7 mAHD using Council’s adopted SKM 2005 levels). A flood barrier will provide active flood protection up to the PMF level.</p> <p>GRC review finds that the proposed development complies in this regard.</p>
5	<p>Unless otherwise approved by Council and provided this does not obstruct or displace floodwaters, the level of the driveway providing access between the road and parking spaces shall be no lower than 0.2 metres below the 1% AEP (100 year ARI) flood level.</p>	<p>At the proposed driveway, 0.2 m below the 1% AEP flood level would equate to 5.8 m AHD under ideal flow conditions and 5.9 m AHD under partial blockage conditions. The minimum finished ground level of the driveway between Hassall Street and the ramp crest is 5.55 m AHD, at least 0.25 m below the minimum level allowed by this control.</p> <p>Molino Stewart, assert that <i>“during overland, creek and riverine floods the recommended flood emergency response strategy is for site occupants to shelter in place and to prevent vehicles exiting the car park and driving into potentially flooded local streets.”</i></p> <p>GRC review finds that the proposed development complies in this regard.</p>
6	<p>Enclosed car parking, and car parking areas accommodating more than 3 motor vehicles, with a floor below the 1% AEP (100 year ARI) flood level, shall have adequate warning systems, signage, exits and evacuation routes. Refer to Flood Warning and emergency Response Planning section of the Parramatta DCP for requirements.</p>	<p>According to Molino Stewart (13 January 2023):</p> <p><i>“Basement levels 1, 2 and 3 all accommodate more than three vehicles and have a floor level below the 1% AEP flood level, but they are designed to exclude 1% AEP floodwaters via passive flood protection measures (i.e. the driveway crest and all potential locations of floodwater ingress through the ground flood slab are above the FPL).</i></p> <p><i>These levels will also be protected from flooding between the FPL and the riverine PMF level by active measures, such as flood gates and flood doors. The basement levels will have signage, exits and evacuation routes.</i></p> <p><i>The basement levels will have a warning system whereby evacuation of the basement levels will be triggered by</i></p>

Reference Control	GRC Comment
	<p><i>flooding of the landscaped area adjacent to the creek, riverine flooding reaching 5% AEP flood levels or Parramatta FloodSmart issuing a Major Flood Warning for Harris Park and Clay Cliff Creek."</i></p> <p>GRC review finds that the proposed development complies in this regard.</p>
<p>7 Restraints or vehicle barriers to be provided to prevent floating vehicles leaving a site during a 1% AEP (100 year ARI flood.)</p>	<p>The basement car parking is contained and protected from flood waters up to the PMF level and therefore cars would be unable to float off site in the 1% AEP event.</p> <p>GRC review finds that the proposed development complies in this regard.</p>
Evacuation	
<p>3 Reliable access for pedestrians required from the site to an area of refuge (including shelter in place) above the PMF level, on site (e.g. second storey) or off site.</p>	<p>Sheltering in place is the adopted emergency response strategy for this proposed development</p> <p>The development will provide unrestricted access via stairs from the basement to Levels 1 and above, which is 1.1 m above the riverine PMF flood level.</p> <p>All of the building's floors above – and not including – the ground floor can therefore function as a PMF refuge. The designated communal flood refuge is on Level 2, which is accessible via the stairs and is 4.9 m above the riverine PMF level.</p> <p>GRC review finds that the proposed development complies in this regard.</p>
<p>4 Applicant is to demonstrate the development is consistent with any relevant flood emergency response plan, flood risk management plan or similar plan.</p>	<p>From Molino Stewart's 20 June 2023 letter:</p> <p><i>"The Parramatta LGA Local Flood Plan (NSW SES, 2019) states that:</i></p> <p style="padding-left: 40px;"><i>1.6.1 The protection and preservation of human life (including the lives of responders and the community) is the highest priority.</i></p> <p><i>The proposed development prioritises the protection and preservation of human life. As local streets in the Parramatta CBD are subject to hazardous flash flooding with little or no warning time, the most appropriate flood emergency response strategy for the site is vertical evacuation, for site occupants to shelter in place above the reach of the PMF. This strategy prevents site occupants from coming into contact with hazardous floodwaters and site occupants would not need to shelter for significantly longer than 6 hours.</i></p>

Reference Control	GRC Comment
	<p><i>The NSW SES flood plan for Parramatta also states:</i></p> <p style="padding-left: 40px;"><i>1.6.2 Evacuation is the primary response strategy for people impacted by flooding.</i></p> <p><i>However, given the potential for flash flooding in the local streets in Parramatta, horizontal evacuation is not suitable as a primary flood emergency response strategy for the site as it would require site occupants to evacuate into potentially flooded streets. This would not be conducive to the protection and preservation of human life and would place site occupants at unnecessary risk.</i></p> <p><i>This is also the case for most sites within the Parramatta CBD.</i></p> <p><i>Under the Parramatta DCP 2011 sheltering in place is a suitable flood emergency response strategy for developments in the Parramatta CBD when horizontal evacuation off site is not feasible. ” ... (And this strategy continues to be supported by the newly adopted 2023 DCP)... ” The relevant development controls were developed by Council to manage flood risk in the Parramatta CBD, where most sites would be subject to H5 or H6 floodwaters in the riverine PMF and would be inundated for several hours. The proposed development manages flood risk to life by complying with these development controls.</i></p> <p><i>The Flood Emergency Response Plan (FERP) prepared for the site states that NSW SES is the lead combat agency for flooding in NSW and that any flood response directive issued by the NSW SES or by delegated authority to others acting on its behalf must be followed. This includes any order to evacuate the site, irrespective of decisions made by management in accordance with the FERP.</i></p> <p><i>If the NSW SES deems that horizontal evacuation will not unnecessarily place site occupants at risk during a particular flood event and issues an evacuation order applicable to the site, the response strategy for the proposed development is to follow that evacuation order.”</i></p> <p>GRC review finds that the proposed development complies in this regard.</p>
<p>6 Adequate flood warning is to be available to allow safe and orderly evacuation without increased reliance upon SES or other authorised emergency services personnel.</p>	<p>The Applicant has stated that a “flood alarm system will be installed to give people enough time to evacuate to higher levels. The flood alarm will be automatically triggered when the flood gates at the southern end of the driveway are activated by riverine or creek floodwaters. The alarm can</p>

Reference Control	GRC Comment
	<p><i>also be manually triggered when riverine flood levels reach 5% AEP levels, Parramatta FloodSmart issues a Major Flood Warning for Harris Park and Clay Cliff Creek or floodwaters are observed in the landscaped area adjacent to the creek."</i></p> <p>Additionally, internal, flood-protected, vertical access routes allow for the safe movement of occupants to Level 2 where sheltering in place can occur above the PMF level.</p> <p>GRC review finds that the proposed development complies in this regard.</p>
Management and Design	
<p>2 Flood emergency response plan required where the site is affected by the 1% AEP (100 year ARI) flood level. Plan is to detail procedures that would be in place for an emergency (such as warning systems, signage and evacuation emergency drills) and should consider the following aspects: (i) preparing for a flood, (ii) responding when a flood is likely, (iii) responding during a flood, and (iv) recovery after a flood. Must be consistent with Flood Warning and Emergency Response Planning requirements outlined in DCP.</p>	<p>A detailed Flood Emergency Response Plan has been prepared for the proposed development (39-43 Hassall Street, Parramatta Flood Emergency Response Plan, Molino Stewart, February 2023).</p> <p>GRC review finds that the proposed development complies in this regard.</p>
<p>3 Applicant is to demonstrate that sufficient area is available to store goods above the 1% AEP (100 year ARI) flood level plus 0.5 metre freeboard.</p>	<p>All store rooms from the ground floor up are above the FPL. Therefore, materials stored on these levels are above the FPL.</p> <p>GRC review finds that the proposed development complies in this regard.</p>
<p>4 No storage of materials below the Flood Planning Level (1% AEP flood plus 0.5 metre freeboard) which may cause pollution or be potentially hazardous during any flood.</p>	<p>There are storage spaces on most of the basement levels, which are below the 1% AEP flood level. However, the basement excludes flooding up to the riverine PMF and therefore these storage spaces will not be flooded in any event.</p> <p>GRC review finds that the proposed development complies in this regard.</p>

In addition to the above controls, which have been explored in detail, GRC also reviewed the broader DCP with regard to flooding. The following sections were reviewed:

- 5.1.1 – Flooding;
- 9.7.5 – Development In And Near Floodways, Riparian Zones And Naturalised Channels;

Of the sub-clauses embedded within these sections (excluding those addressed in Table 5 above), the proposed development is largely compliant excluding the following:

5.1.1 – C.29 (b):

“Unless otherwise advised by Council, facilities must be designed for a refuge stay of at least 72 hours, with longer time periods addressed in design, equipment and provisioning.”

The refuge facilities have not been designed for a 72 hour refuge stay, but to facilitate a refuge stay of 6 hours, with a 24 hour back-up power supply also provided.

Given that a riverine PMF would only isolate the site for a maximum of 6 hours, the provision of back-up services for 6 hours is believed to be sufficient to shelter site occupants during a flood.

However, given the specific time period mentioned in this sub-clause, it is GRC’s opinion that the proposed development is **not compliant** in this regard.

It is GRC’s view that the proposed development complies with the majority of the requirements outlined in the currently adopted LEP and DCP.

GRC appreciates that where it does not strictly comply, alternative solutions have been provided by the Applicant and their flooding consultants (Molino Stewart and Lyall & Associates) to result in adequate protection of life and property from flood impacts.

The controls for which compliance is not explicitly achieved are:

- The refuge facilities have not been designed for a 72 hour refuge stay so the proposed development is not compliant in this regard. It may be prudent for the Applicant to revise whether a longer term of emergency provision may be achieved; and
- The level of the driveway providing access between the road and parking spaces is lower than the required 0.2 metres below the 1% AEP (100 year ARI) flood level and therefore not compliant. It is currently proposed to have an elevation 0.25 m below the 1% AEP flood level. GRC understand that Council are able to approve driveways below the required level provided this does not obstruct or displace floodwaters.

Conclusion

GRC Hydro are a firm specialising in flood engineering work including flood modelling and floodplain risk management. GRC has reviewed the proposed development against the newly adopted Parramatta DCP and LEP (2023). Key to the assessment is the site-specific flood assessment carried out by the Applicant.

Firstly, it is clear that the applicant had no choice but to carry out a site-specific flood assessment. In order to assess the potential flood impact of a proposed development a model is required and the 2005 model is not available (and arguably is it no longer fit for purpose given the improvements in flood modelling and physical changes to the catchment that have taken place since the 2005 modelling was conducted).

Secondly, GRC are of the opinion that the Applicant’s site-specific flood modelling has been carried out according to best practice. As such, it is GRC’s opinion that the results derived can confidently be relied

upon. Flows used by the applicant are higher than those utilised in the previous Council endorsed study (2005), which constitutes a conservative approach, and the hydraulic outcomes are entirely plausible.

And finally, GRC, as per our initial report, have carefully reviewed the design and found it to be largely compliant with the City of Parramatta's LEP and DCP (2023) requirements. Potential non-compliances have been documented above.

Overall, what is proposed is a residential building on the outer edge of the Parramatta River floodplain. In the Clay Cliff Creek 1% AEP event, shallow depths do impact the site, however the hazard of these is low and the flood risk can be managed by a shelter in place strategy. For larger, rarer flood events the building has been designed to comply with the City of Parramatta's DCP requirements and as such, there are passive measures to prevent inundation up to the 1% AEP plus 0.5 m level and then mechanical means to prevent the Parramatta River inundating the building basement right up to the level of the rarest possible event, the PMF. The use of mechanical means (flood gates) for this purpose is endorsed by their inclusion in the Parramatta DCP.

Yours Sincerely



Steve Gray

Director

NER 2435438

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Appendix A

Job Number: 230020
Date: 30th March 2023

GRC Hydro
Level 20, 66 Goulburn Street
Sydney NSW 2000

Elena Slogeris
NSW Department of Planning and Environment
4 Parramatta Square, 12 Darcy Street,
PARRAMATTA NSW 2150

Tel: +61 [REDACTED]
www.grchydro.com.au

Dear Ms Slogeris,

Re: Flood Advice for a State Significant Concept Proposal – 39-43 Hassall Street, Parramatta, NSW, 2150 – Build-to-Rent Residential Development

Introduction

A mixed use, State Significant Development (SSD) is proposed for 39-43 Hassall Street, Parramatta (the site). The site is currently vacant and the built form that was previously present at the site has now been removed.

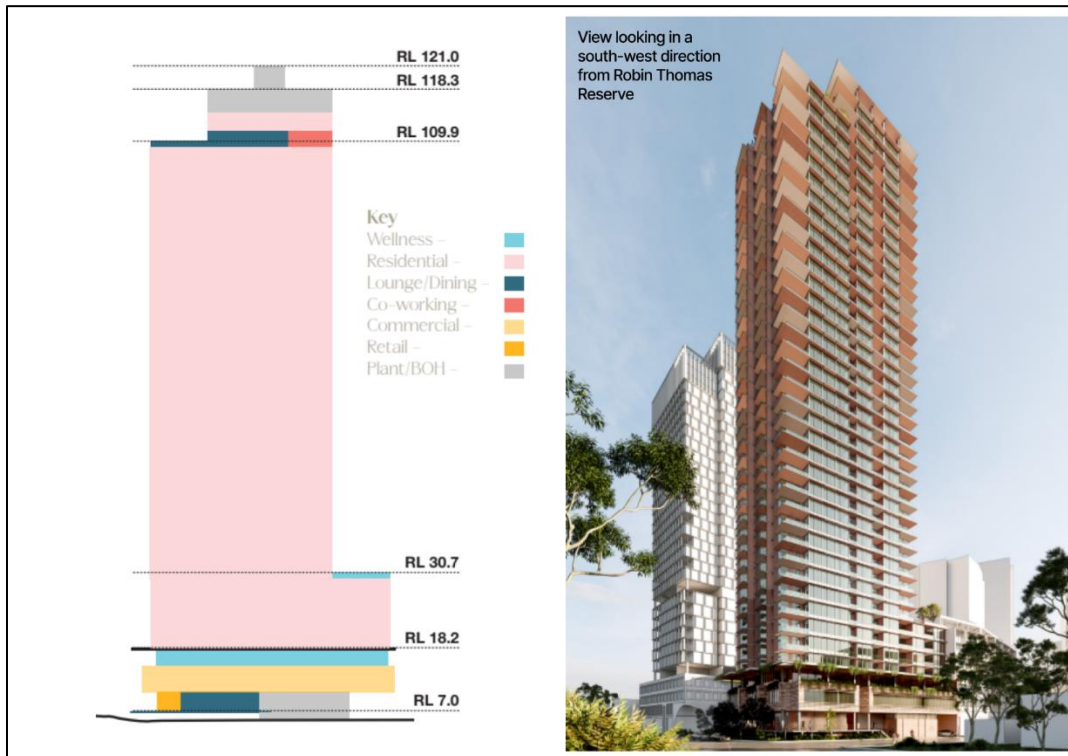
Figure 1 – The Site Location



The proposed development consists of a mix of the following uses over 34 storeys:

- Retail;
- Commercial; and
- Build-to-Rent Residential.

Figure 2 – The Proposed Development – Usage Cross-Section and Artists Impression of Facade



GRC Hydro (GRC) has been engaged to review the flood-related assessments that accompanied the SSD proposal.

In aid of conducting this assessment, GRC has reviewed the following:

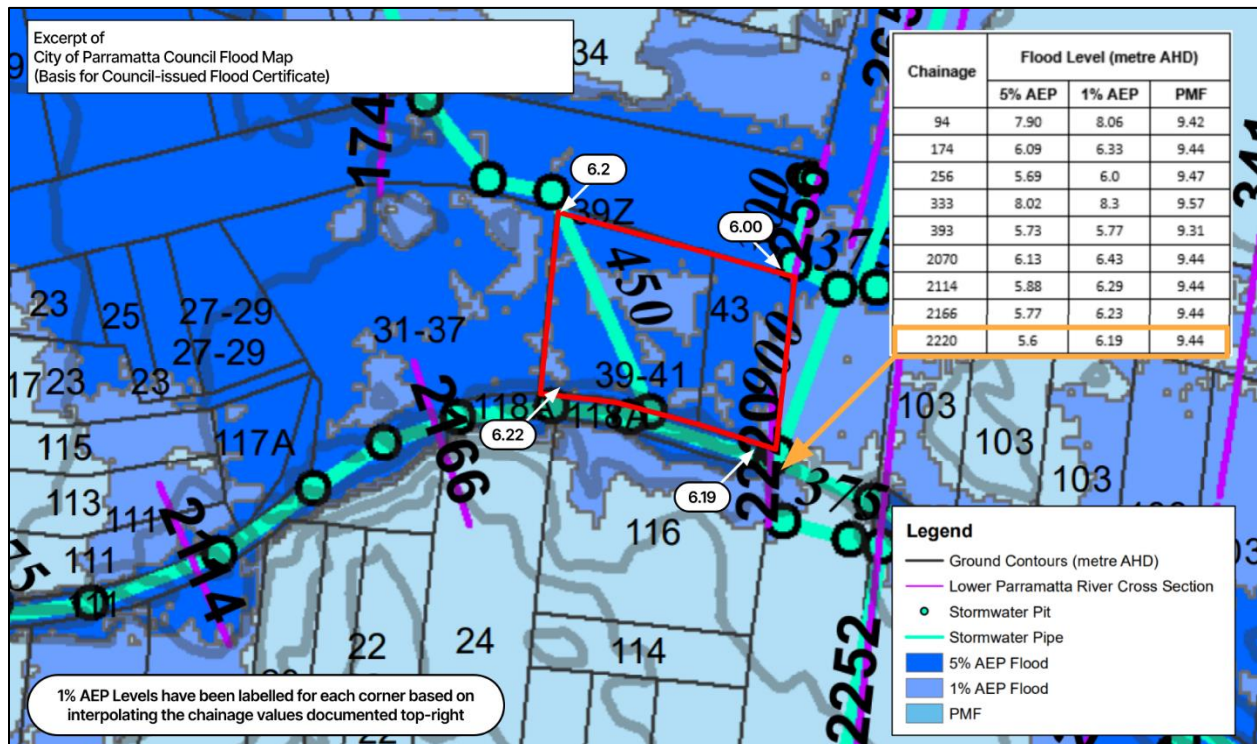
- 39-43 Hassall Street Flooding Investigation, Lyall & Associates, December 2022;
- Re: 39-43 Hassall Street Parramatta – Flood Risk Assessment, Molino Stewart, 13 January 2023
- Architectural Report, Novus on Harris, Clay Cliff Creek, 39-43 Hassall Street, Parramatta, NSW, Rothelowman, December 2022;
- Flood Enquiry Information Issued, Property Details: Address 39-41 Hassall Street, Parramatta NSW 2150, City of Parramatta, December 2021;
- Flood Emergency Response Plan, 39-43 Hassall Street, Parramatta, Molino Stewart, February 2023.

Local Flood Behaviour

Council's Flood Mapping

The City of Parramatta (Council) has issued Flood Enquiry Information for the subject site and an excerpt of their issued flood mapping is below in Figure 3.

Figure 3 – Excerpt of City of Parramatta Council Flood Map

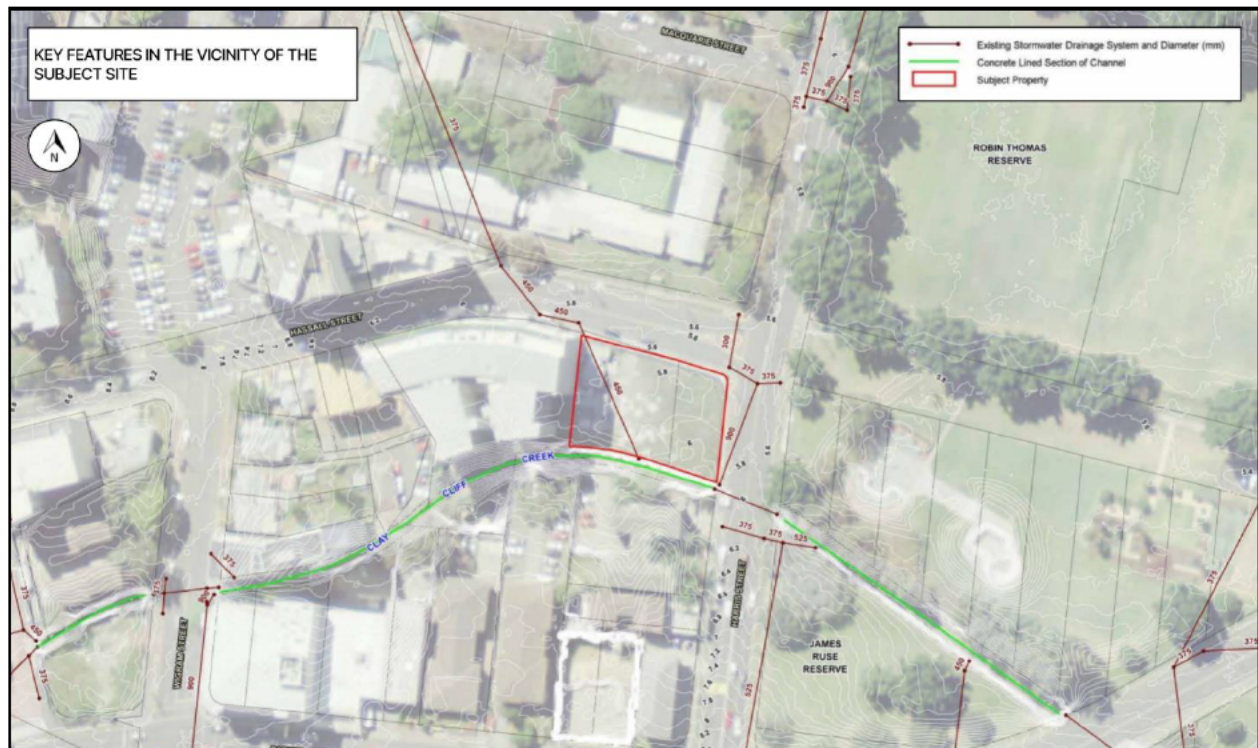


The site is situated adjacent to the 2220 chainage point on Clay Cliff Creek and the flood levels at this point for various design flood events are as follows:

- 5% AEP event: 5.60 mAHD
- 1% AEP event: 6.19 mAHD
- PMF event: 9.44 mAHD

The site is currently vacant, and the key flood-relevant features in the vicinity of the existing site – including Clay Cliff Creek on the site's southern border – have been documented below in Figure 4.

Figure 4 – Key Features in the Vicinity of the Subject Site (Lyll & Associates, 2022)



Local Flood Mechanisms

The site is flood liable and is subject to the following flood mechanisms:

- **Overland flow** resulting from rainfall in the local catchment overwhelming the local drainage infrastructure (pits and pipes), building up and attempting to drain overland. The local catchment drains toward Clay Cliff Creek via the site and Hassall and Harris Streets (see Figure 6). For example, overland flow collects in the local trapped-low-point (or ‘sag’) at the intersection of Hassall and Harris Streets and could impact vehicle and pedestrian traffic for the development.
- **Creek flooding** can result from Clay Cliff Creek rising, overtopping its banks and spilling into the site. This is likely to be the primary flooding mechanism in a 1% AEP flood.
- **Riverine flooding** rising from Parramatta River up Clay Cliff Creek resulting in backwatering of local drainage which in turn contributes to a rising of local flood levels. Riverine flooding becomes an important contributor to flooding at the site in events rarer than 1% AEP (as discussed in Molino Stewart, 2023).

Lyll & Associates Review of Existing Modelling

The modelling undertaken to produce the *Lower Parramatta River Floodplain Risk Management Study* (SKM, 2005) – the study which has formed the basis of flood planning levels for this site – has been reviewed by Lyll & Associates as part of their flooding investigation.

The SKM study involved the development of a hydrologic model of the catchments which contribute to flow in the Lower Parramatta River using RAFTS software. This RAFTS model was used to generate discharge

hydrographs which were used as input to a quasi-two-dimensional hydraulic model which was developed using the MIKE 11 software. The MIKE 11 model was used to convert flows to peak flood levels and flow velocities in the study area.

Lyll & Associates also reviewed an assessment of Clay Cliff Creek that was conducted by SWC in 2002, a study that they believe over-estimated the flow rate in the creek as per the reasoning outlined on page 3, chapter 2 of their flooding investigation.

Lyll & Associates Model Update

Following a review of this previously conducted modelling, Lyll & Associates opted to develop a new model for the site, stating that: *“in order to more accurately define flooding behaviour in the vicinity of the subject property a two-dimensional hydraulic model was developed using the TUFLOW software.”*

GRC understands that the boundary conditions have been adopted from the MIKE 11 model that was used in the development of the *Lower Parramatta River Floodplain Risk Management Study* (SKM, 2005).

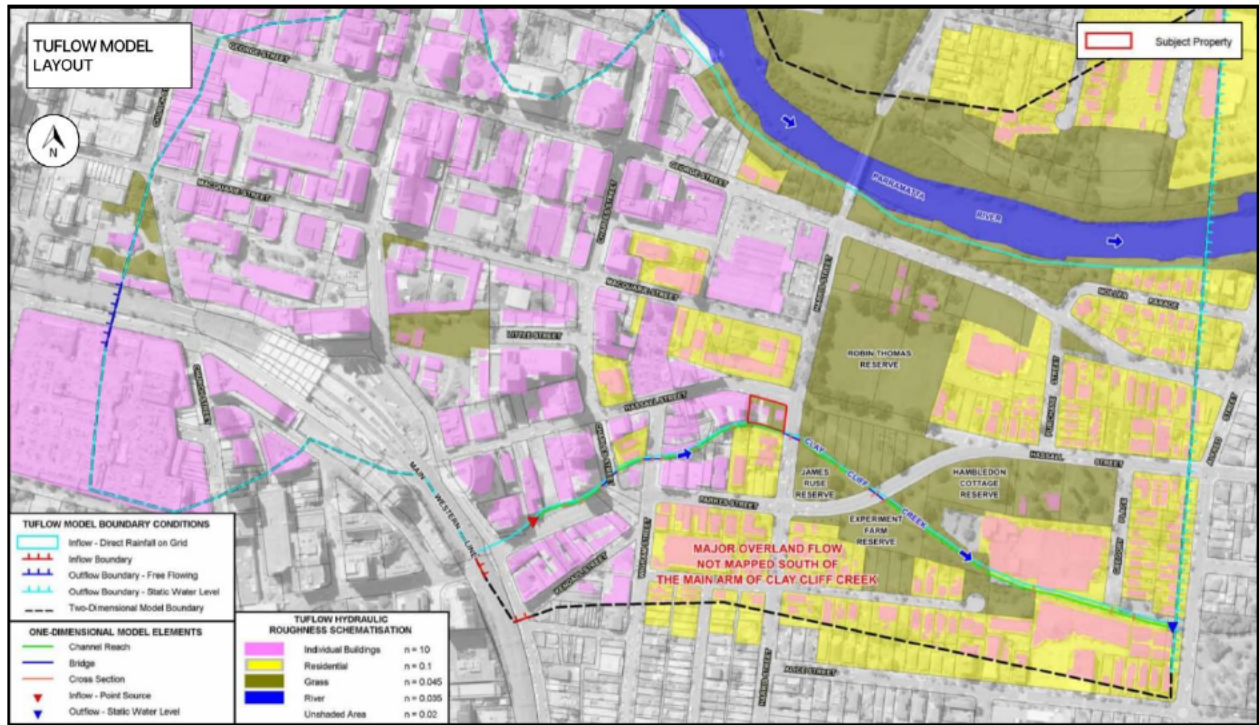
Details of the local stormwater drainage system were not incorporated in the TUFLOW model, as Council requires that the assessment of local catchment flood behaviour be based on the assumption that it is 100% blocked.

A blockage factor of 15% was adopted for the bridge openings along Clay Cliff Creek. The basis of this is documented on page 5 of their flooding investigation (under ‘Blockage Factors’).

In order to check the results of the TUFLOW model, as well as those of previous studies, a one-dimensional cross sectional based hydraulic model was developed of the main arm of Clay Cliff Creek using the HEC-RAS software.

The TUFLOW model layout has been documented in Figure 5.

Figure 5 – TUFLOW Model Layout



The Flooding Investigation for this site (Lyall & Associates, 2022) documents that the existing site is flood liable. Figure 6 below identifies the flood depths for the 1% AEP event in the existing scenario.

Existing Flood Liability

The results of the Lyall & Associates TUFLOW modelling for the existing scenario is documented and discussed below.

Figure 6 – Flood Depths and Levels – 1% AEP Existing Conditions (Lyall & Associates, 2022)



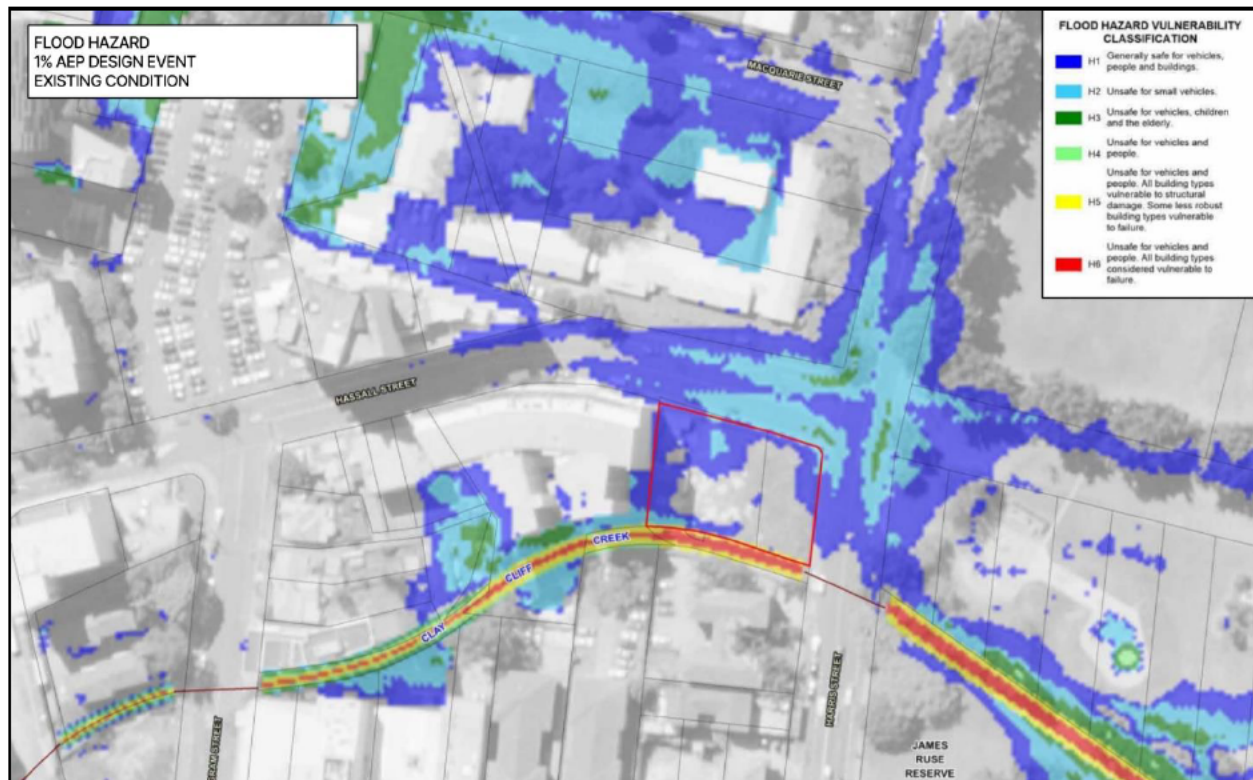
In the 1% AEP event, three of the four corners of the site (all aside from the south-eastern corner) are inundated to a depth of 0.3 m with the south-western corner as deep as 0.5 m.

On the intersection of Harris and Hassall Streets (north-east of the site) the edges of the roadway are inundated to a depth of approximately 0.8 m.

Clay Cliff Creek flows west to east immediately south of the site's southern border. As documented in Figure 6, flow conveyed in this watercourse largely remains contained within its banks as it passes the site.

It should be noted that the peak 1% AEP flood level directly upstream of Harris Street, as modelled by Lyall & Associates, is in the order of 5.8 mAHD – approximately 0.4 m lower than the 1% AEP level quoted in the Council-issued flood information.

Figure 7 – Flood Hazard Categories – 1% AEP Existing Conditions (Lyll & Associates, 2022)



The modelled flood hazard categories in the 1% AEP event (see Figure 7) do not exceed H2 – the second-most minor hazard category.

The hazard in Clay Cliff Creek, immediately south of the site, is as high as H6, the most significant hazard classification. It's worth noting that this hazard category doesn't encroach on the site and remains within the defined channel.

The PMF design event was not modelled as part of this study.

Proposed Development

The proposed works for Stage 1 of the project were represented in the Lyll & Associates TUFLOW model to reflect post-development conditions as follows:

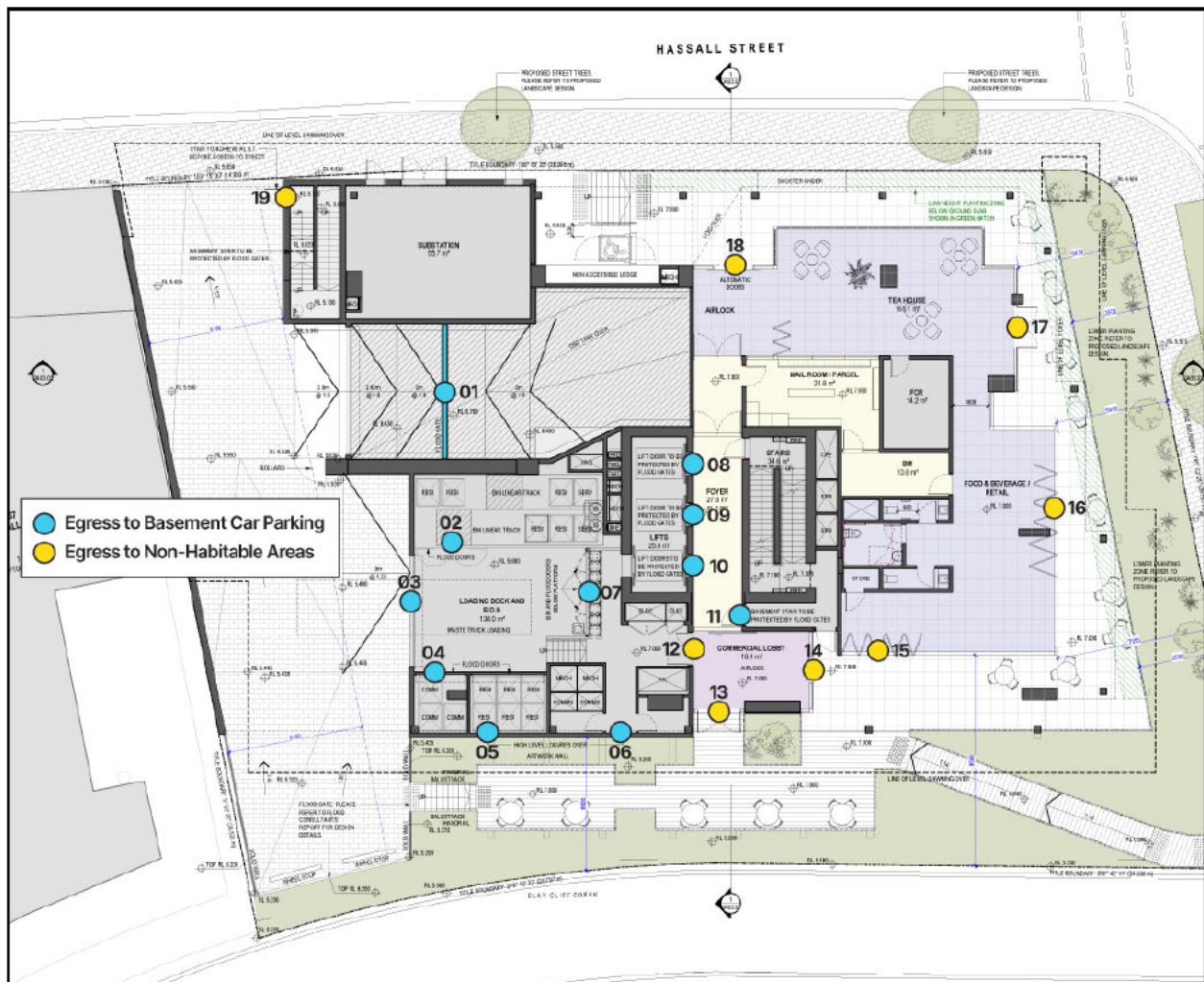
- *Natural surface levels were raised within the footprint of the proposed building to reflect the blocking effect that it would have on flow.*
- *Natural surface levels on the remainder of the subject property were modified to reflect finished surface levels shown on the attached ground floor plan.*
- *The flood protection wall/barrier arrangement that is proposed at the southern end of the proposed concrete driveway was modelled as a ridgeline with an elevation of RL 6.2 m AHD.*
- *The hydraulic roughness values on the subject property were modified to reflect the concrete driveway which is proposed along the western boundary of the subject property, as well as the landscaped areas that are proposed along its southern and eastern boundaries.*

- The elevated jetties and walkways which are proposed on the southern side of the proposed building were modelled as layered flow construction shapes, with the deck thickness assumed to be equal to 0.15 m.

Based on the documentation regarding the proposed development that GRC has reviewed, these model changes appear reflective of the proposed post-development scenario.

This proposed development footprint is documented below in Figure 8 with annotations added by GRC to identify entrances and flood gates (as identified in Rothelowman’s ground floor plan (DA01.06, 05/12/2022) for the proposed development).

Figure 8 – Proposed Development Footprint at Ground Level (Rothelowman, DA01.06, 05/12/2022)



Post-Development Flood Liability

TUFLOW modelling of the site applying the above-listed model changes to represent the proposed post-development conditions has resulted in the following results in the 1% AEP event.

Figure 9 – Flood Depths and Levels – 1% AEP Post-Development Conditions (Lyll & Associates, 2022)

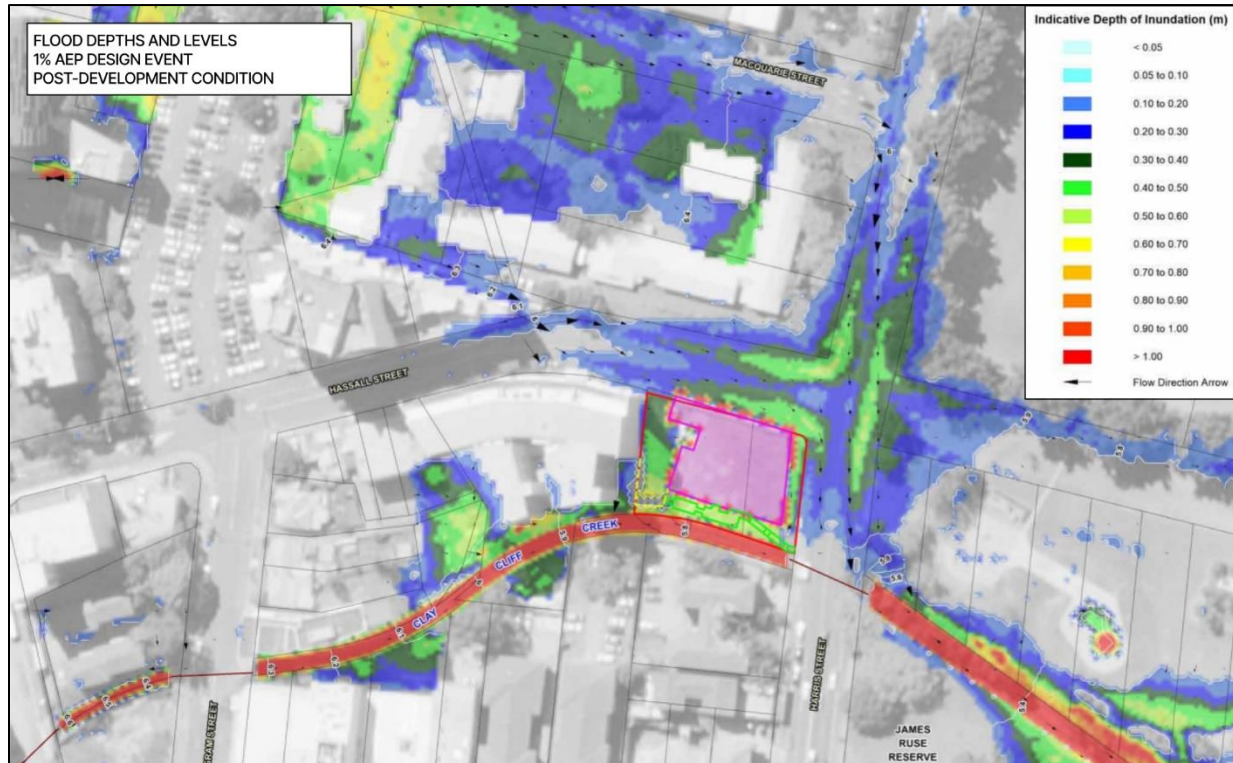


Figure 9 identifies the modelled flood depths and levels for the 1% AEP event in the proposed post-development case. The depths across the site are predominantly below 0.5 m with a pocket in the south-eastern corner rising up to approximately 0.7 m deep.

Figure 10 – Flood Hazard Categories – 1% AEP Post-Development Conditions (Lyll & Associates, 2022)

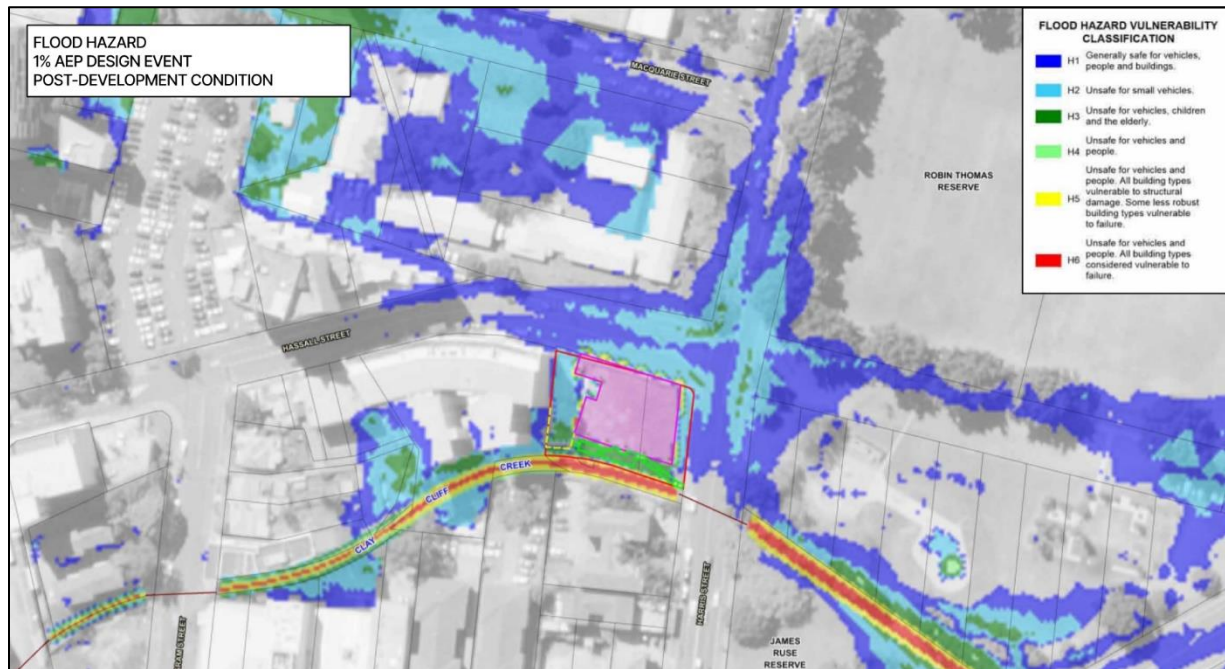


Figure 10 identifies the post-development hydraulic hazard categories in a 1% AEP event. There is some increase in hazard in the southern border and in the south-western corner where the hazard category has increased from H1 and H2 in the existing case, to H3 and a tiny pocket of H4 in the post-development case.

This area is not proposed to be a highly trafficked area. It is proposed that this area will include a paved area for car parking and a raised outdoor deck for seating at an elevation on 7 mAHD in a location where the 1% AEP flood level (as modelled by Lyll & Associates) is predicted to be in the order of 5.8 mAHD.

The proposed driveway entrance point on Hassall St – which also coincides with the primary pedestrian entrance for the development – has been modelled to be H1 (low hazard) and generally safe for vehicles, people and buildings.

Figure 11 – Flood Level Impact – 1% AEP Post-Development Conditions (Lyll & Associates, 2022)



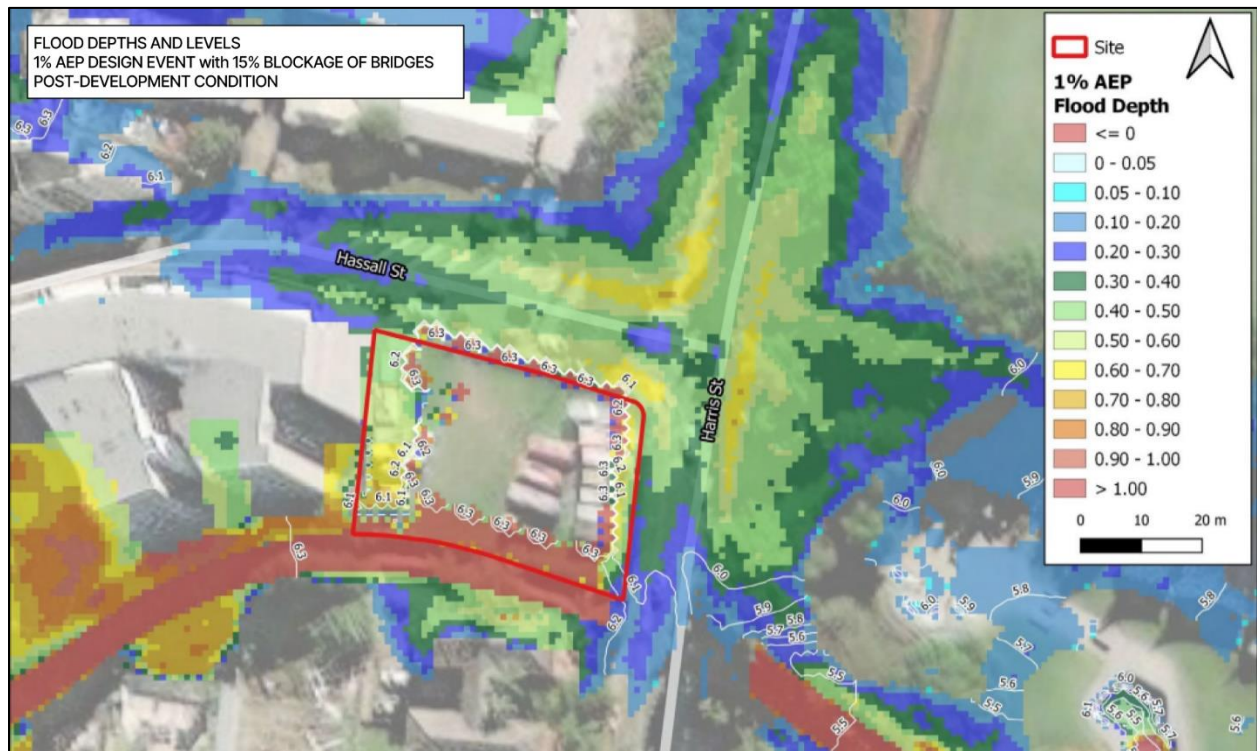
The flood level impacts posed by the potential development appear to be restricted to the subject site and hence are compliant.

Incorporating Blockage Factors

Figure 12 documents the modelled peak flood depths and levels when incorporating a 15% blockage factor to the bridges along Clay Cliff Creek.

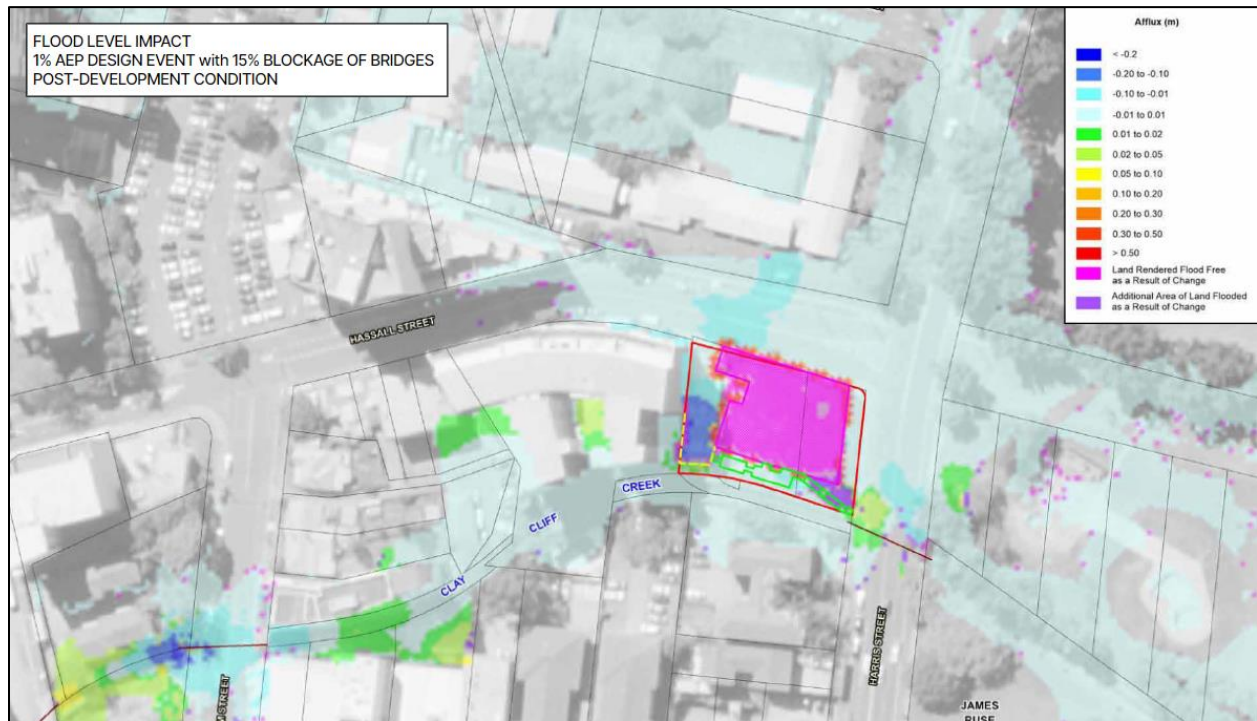
As per this modelling, the 1% AEP flood level is approximately 6.1 mAHD in the south-western corner of the site and about 6.3 mAHD for most of the remaining southern border. The flood level in this scenario still remains largely below that of the proposed development's ground level (sitting at 7 mAHD – 0.7 m above this modelled level).

Figure 12 – Flood Depths and Levels – 1% AEP Event with 15% Blockage Factor in Post-Development Conditions (Lyll & Associates, 2022)



Under this partial blockage scenario, the potential flood level impact posed by the proposed development was modelled (Figure 13). For the most part, the majority of impacts are restricted to the site itself, however there are some areas where there are small increases (0.01 to 0.10 m) and decreases up to 0.2 m.

Figure 13 – Flood Level Impact – 1% AEP Event with 15% Blockage Factor in Post-Development Conditions (Lyll & Associates, 2022)



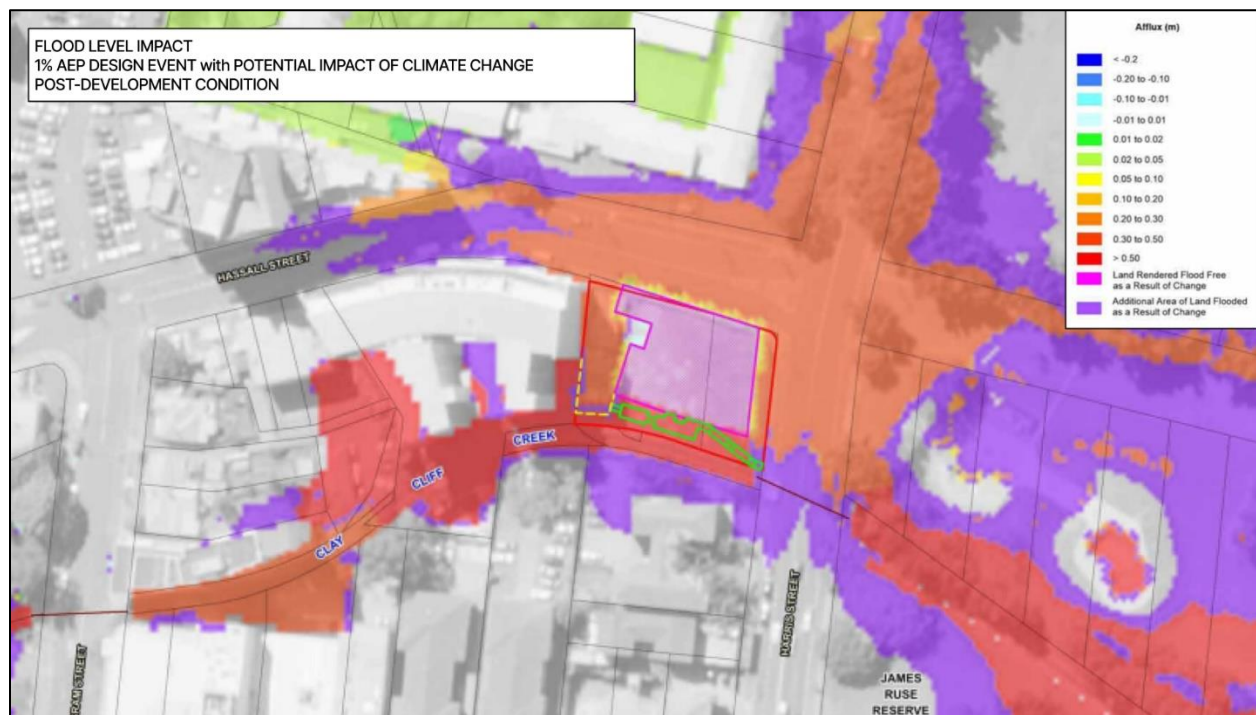
Incorporating the Potential Impact of Climate Change

Lyall & Associates has modelled the potential impact posed to the site by climate change (in the post-development case). The basis for this modelling is discussed in Section 5.4.2 on page 8 of the Flooding Investigation.

Figure 14 documents the potential flood level impact when incorporating this potential climate change impact.

In this scenario, impacts on and immediately adjacent to the site range from as little as 0.1 m to potentially greater than 0.5 m on the southern border where the site meets Clay Cliff Creek.

Figure 14 – Flood Level Impact – 1% AEP Event with Potential Impact of Climate Change (Lyall & Associates, 2022)



The Proposed Development and Flood Affection at the Site

The Flood Risk Assessment conducted by Molino Stewart has assessed the proposed development against Lyall & Associates' flood modelling for the subject site with regard to the Parramatta Development Control Plan 2011 Section 6.7 (PDCP, 2011). This is discussed in detail in pages 29 to 31 of the Flood Risk Assessment (Molino Stewart, 2023).

The DCP cites a Flood Planning Level (FPL) of 1% AEP + 0.5 m freeboard. In summary – not including specific clauses mentioned in the DCP – the following floor levels are required:

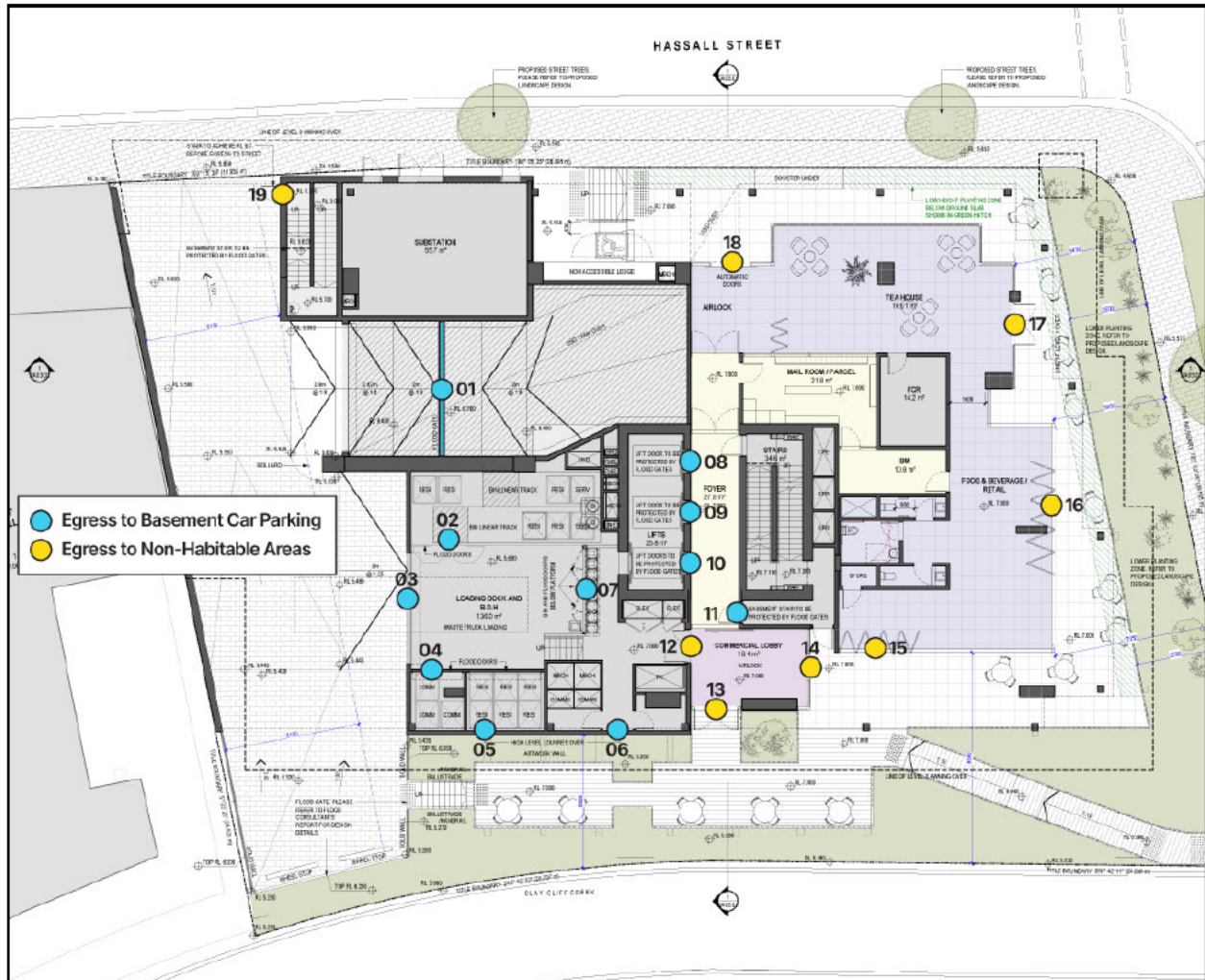
- For habitable uses, the floor level is required to be above this FPL.
- For commercial and retail uses, the floor level can be below this FPL provided that “*satisfactory flood hazard and risk assessment is undertaken and appropriate flood mitigation measures are incorporated accordingly.*” (PDCP, 2011, S 6.7, C.05).”

- Basement parking is permissible below the FPL provided it's protected up to the PMF level – which for this site, is 9.5 mAHF as per SKM, 2005.

Molino Stewart has provided comment in their Flood Risk Assessment that they believe the proposed development meets the floor level requirements of the DCP.

In order to verify this, GRC has assessed the FPLs against the egress points identified for the proposed development's ground floor (Figure 15 below).

Figure 15 – Flood Egress Points, Floor Levels and Usage at Ground Level (Rothelwman, DA01.06, 05/12/2022)



The elevation at which each of these points is flood protected has been outlined in Table 1. The appropriate Flood Planning Levels – as identified on page 47 of Molino Stewart's Flood Risk Assessment – have been identified at each location for comparison.

Table 1 – Elevations of Ground Floor Entrances and Flood-Specific Infrastructure (Points for Potential Flood Egress)

Location No. ¹	Description	Elevation ² (mAHD)	Flood Planning Level (mAHD) <i>Lyall & Associates, 2022</i>	PMF (mAHD) <i>SKM, 2005</i>
01 •	Driveway Crest	Crest: 6.70 Top of Gate: Ceiling Height ³	6.6	9.5
02 •	Loading Dock Flood Doors	Crest: 5.60 Top of Doors: Not Known ³	6.6	9.5
03 •	Loading Dock Entrance	5.60	6.6	9.5
04 •	Loading Dock Flood Doors	Crest: 5.60 Top of Doors: Not Known ³	6.6	9.5
05 •	Louvre Windows	Not Known ²	6.8	9.5
06 •	Louvre Windows	Not Known ²	6.8	9.5
07 •	Loading Dock Flood Doors	Crest: 5.60 Top of Doors: Not Known ³	6.6	9.5
08 •	Flood Gate protecting Elevator Shaft	Crest: 7.00 Top of Gate: Not Known ³	6.6	9.5
09 •	Flood Gate protecting Elevator Shaft	Crest: 7.00 Top of Gate: Not Known ³	6.6	9.5
10 •	Flood Gate protecting Elevator Shaft	Crest: 7.00 Top of Gate: Not Known ³	6.6	9.5
11 •	Flood Gate protecting the Stairway to the Basement	Crest: 7.00 Top of Gate: Not Known ³	6.6	9.5
12 •	Loading Dock to Commercial Lobby Entrance	7.00	6.6	-
13 •	Commercial Lobby Entrance	7.00	6.7	-
14 •	Commercial Lobby Entrance	7.00	6.7	-
15 •	Entrance to Retail Area	7.00	6.7	-
16 •	Entrance to Retail Area	7.00	6.7	-
17 •	Entrance to Retail Area	7.00	6.6	-
18 •	Entrance to Retail Area	7.00	6.6	-
19 •	Entrance to Stairwell	5.70	6.6	-

¹ Egress points leading to either the basement car park • which requires flood protection up to the PMF level, or to a non-habitable use • which may have a floor level lower than the FPL depending on circumstances documented in PDCP, 2011, S 6.7, C.05

² Elevations derived from the Rothelowman Ground Floor Plan (DA 01.06, 05/12/2022).

³ GRC request clarification from Molino Stewart of the level (mAHD) of flood protection offered at these locations so that GRC can better assess how it protects against a PMF event.

NSW Government Response to the NSW Independent Flood Inquiry

GRC has reviewed the NSW Government Response to the NSW Independent Flood Inquiry with regard to the flood-related components of this development proposal.

The recommendations outlined in the Government Response were primarily in aid of bolstering the ability of Government and emergency services to better attend to flood emergencies and develop a better understanding of flood emergency response in the community.

In the main, these recommendations don't appear to currently require additional actions of actors below the level of State and Local Government.

Recommendation 18 calls for Government to “reinforce its adoption of a risk-based approach to calculating the flood planning level for planning purposes and, through the NSWRA, immediately start a process of revising all flood planning level calculations in the state’s high-risk catchments.”

Should the actioning of this recommendation potentially alter the existing flood planning levels for the subject site, the applicant should be advised of this at the earliest possible opportunity.

GRC Summary

On initial review, GRC potentially agree with Molino Stewart that the development appears compliant in terms of flooding given that:

- Flood level impacts posed by the potential development are largely limited to the subject site;
- Active flood protection measures, including multiple flood gates and doors, have been proposed to:
 - offer safe evacuation and/or shelter-in-place during a flood emergency; and
 - protect the basement car park from inundation up to and including a PMF event.

However, GRC would like some clarity on the following points in order to better understand, or verify, the proposed development’s relationship to the local flooding regime. As such we request that:

- Lyall & Associates offer more information as to why it was prudent to update the model in TUFLOW and why they believe that the TUFLOW modelling results are more representative of local flood behaviour than the Council-provided flood levels. Verification details would be appropriate in this regard;
- Lyall & Associates offer some more information as to why they believe that 15% is an appropriate blockage factor for the bridges crossing Clay Cliff Creek, including the Harris Street bridge;
- Lyall & Associates provide additional information – in addition to Section 5.4.2 of the Flooding Investigation – as to why they believe the potential climate change conditions adopted for this modelling, including the stated tailwater increase, would be representative of the potential climate change impact in this catchment;
- Lyall & Associates provide a figure documenting the flood impact of the proposed development on flood behaviour under potential future climate change conditions in a 1% AEP event. In other words, a figure that identifies the flood level difference between:

- The 1% AEP event with potential future climate change conditions – post-development scenario; and
- The 1% AEP event with potential future climate change conditions – existing scenario.
- Lyall & Associates provide an assessment of the impact of proposed works given assumed 50% blockage of Harris Street bridge only;
- Molino Stewart confirm that there are no additional egress points on the ground floor than those identified in Figure 15 above; and
- The Flood Risk Assessment mentions that protection is offered up to the PMF level. GRC request that Molino Stewart confirm the level (in mAHD) of protection offered by the flood gates and doors identified in Figure 15 and Table 1 above.

GRC Hydro will utilise clarifications in order to assess the suitability of the proposed works versus Flood Planning Level requirements and also to assess whether or not blockage and/or climate change inclusions may affect compliance of proposed works with impact criteria.

Yours Sincerely



Steve Gray
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